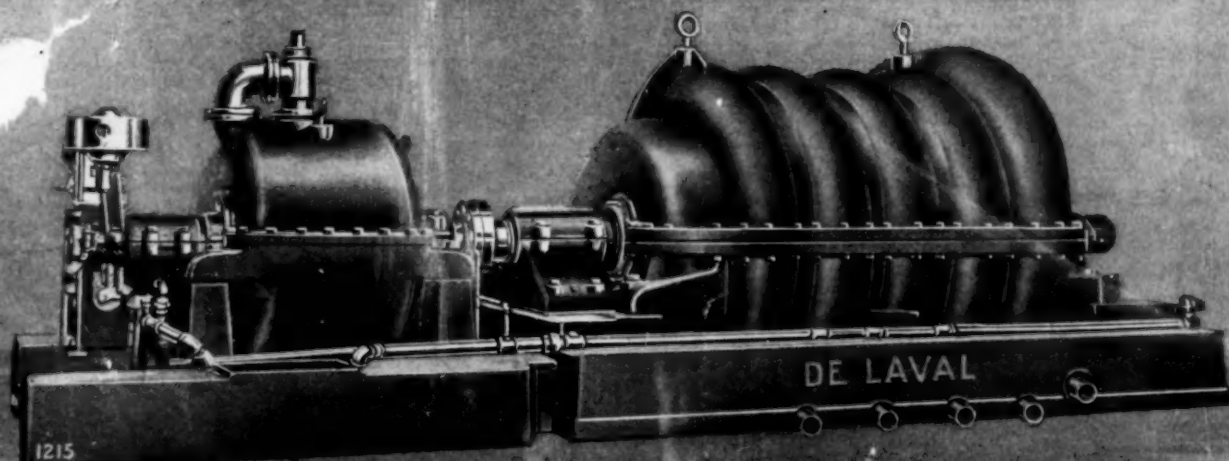


# CHEMICAL & METALLURGICAL ENGINEERING

New York, N. Y., June 9, 1920

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67

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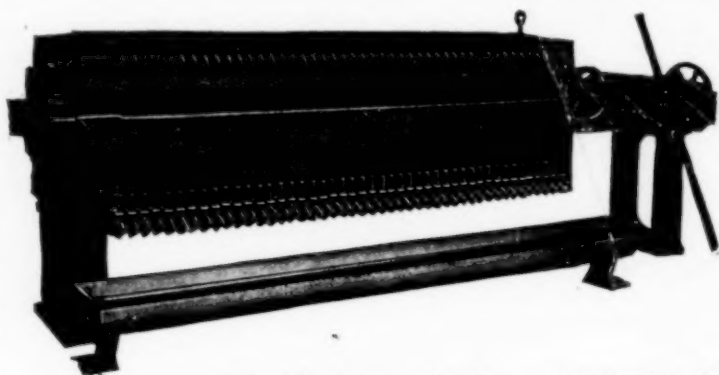
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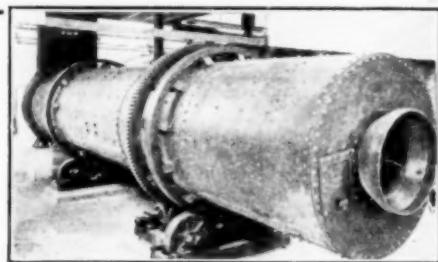


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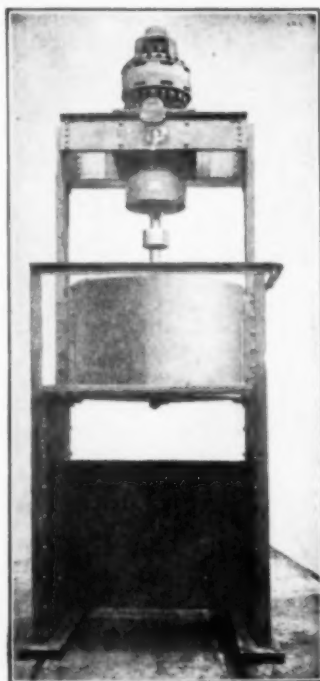
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Number 23

## The Federated American Engineering Societies

**S**ELDOM does the habitué of technical and general gatherings absorb so many inspirational thoughts tumbling fast through a medium electrified with a sharp clash of intense purpose as at Washington last week. This alone would mark the recent organization of The Federated American Engineering Societies. Not only were the brief and pithy addresses from eminent engineers in various walks of life full of allusion to the widespread value of engineering thought and achievements, but even the sharpest discussion was based entirely upon the best and most effective method of giving service. Service was the keynote—not struck by the first speaker of the meeting and then forgotten, but animating the proceedings to the end.

As already noted in these columns, very divergent views may readily be held by any two men as to the proper way to effect a national organization through which the engineer collectively may exert the influence his technical training and moral integrity deserve. (It is perhaps unnecessary to argue that at no recent instant has the need for unselfish and competent service to the public been so pressing.) Unsatisfied with the apparent conservatism of the old-established national and regional engineering societies, the American Association of Engineers has gathered together in a democratic organization many thousand men—from engineers of highest technical achievement to neophytes—and has already executed difficult and salutary undertakings most creditably. Leavened by this yeast, or in the natural course of events—it does not matter—even the most conservative of the older organizations recognized the insistent desire on the part of an engineer to become an influential citizen, and actively sponsored the idea of federating themselves together to promote this consummation.

At the organizing conference there was consequently much inflammable material. It was only natural to doubt whether the democratic idea was so fundamentally divergent from the federation idea that the societies embracing these tenets could find no common ground. Those who could not measure the bigness of the individual delegates freely predicted steam roller methods on the part of the founder societies and their satellites, and last-ditch obstruction from the A.A.E. and its sympathizers. However, the event confirmed the optimistic. The activity of an impromptu steering committee was instantly halted by the absolute impartiality of CALVERT TOWNLEY, the permanent chairman, and the bitterness which is inseparable in a losing fight never even approached the petty devices it so often encourages.

This happy condition was possible only because it was the instinctive desire of the hundred or more indi-

viduals present to organize nationally for service—service to the public and the engineering profession. This was the evident common ground. Debate as to the most nearly perfect method of reaching this end never descended to the acrimonious, and often approached the inspiring. Particularly it was evident at the climax of the meeting, when on the first roll call taken on the resolution “that it is the sense of this convention that the proposed organization should be an organization of societies or affiliations and not of individuals,” the A.A.E. representatives, responding first, voted yes to a motion which the casual observer might think would submerge their individuality, simply stating that they were present not as obstructionists, but as co-operators, to aid in the work in any way possible.

This, it seems apparent, should be the principal thought carried home by the various delegates. Many provisions of the proposed constitution and bylaws may not appeal strongly to individual societies or individual members of the societies. The whole plan of operations may appear fundamentally wrong. Frankly, we may confess that we are yet to be convinced that a federation is better than a democracy, for reasons some of which have already been given in these columns. But every one, it seems certain, should approach the debatable points from the standpoint so clearly seen at Washington, that the common ground is service, and that engineers should co-operate and not obstruct. The least each individual can do is to consider carefully the debatable features from the standpoint that the general movement is desirable. If any detail is wrong, co-operate in a sincere effort to correct it! Help as far as you can! The least which that involves is a sincere hope that any finally accepted organization may succeed, and will not need to overcome active enmity.

## Make It Definite

**T**HE work of the American Chemical Society Committee on Standardized Apparatus has led the chairman to make a very excellent suggestion which the authors of technical articles should heed. He recommends that the description and illustration of apparatus should be made as definite as possible, particularly including the complete dimensions. Anyone who has undertaken to reproduce the results of physical measurements or organic reactions in the laboratory as described by other investigators knows how frequently he is at a loss to know just how some essential detail of the apparatus was cared for. All too much of our scientific literature is seriously lacking in definiteness and every author who wishes to make his record of investigation of greatest value to posterity should bear in mind the need of giving all essential dimensions of apparatus very clearly.



### The Haber Process In the United States

WHILE it is conceded that the Haber process of nitrogen fixation is still in the experimental stage in this country, as evidenced by the fact that continuous production on any considerable scale has not been accomplished, much progress has been made toward its ultimate commercial development. Within the next few years we should witness the successful completion of experimental work on catalysts by the Army Ordnance and the General Chemical Co.; the reconstruction of U. S. N. P. No. 1 at Sheffield, Ala., and the completion of the plant of the Atmospheric Nitrogen Corporation at Syracuse, N. Y. When these two small plants are producing ammonia without interruption the demonstration of the American adaptation of the method will have been successfully made.

We are surfeited these days with the output of the professional muckrakers who make the mistake of attacking legitimate governmental activities along with the projects, very few in number, which really deserve investigation. The large enterprises started during the war and temporarily abandoned because we were blessed with an earlier suspension of hostilities than was expected are still as important to the nation as if the fighting had continued. The efforts expended will be just as valuable in the prosecution or, let us hope, prevention of the next war. For the person who believes that wars may be ended for all time is neither a student of history nor of human nature as manifested collectively by national existence.

It is further very fortunate that the nitrogen industry may serve the interests of peace while keeping pace with the progress of other nations in the art of war. It excels the Army and Navy in this regard and is quite as essential for national preparedness.

Let not the efforts of those technical men who would have preferred to be heroes in actual combat be in vain! They labored sleeplessly in the hope of supporting the men at the front and when the Armistice was signed said, "Well, anyway, we've done a devil of a lot for the next time!"

The nitrogen fixation business must be carried on by the Government first as a measure of preparedness and second to meet the needs of the fertilizer industry. The question of wasteful expenditures or graft in the building of the plants is a matter for prosecution in the courts and has nothing to do with proposed operation and development by the Government of a scientific process for manufacturing a commodity that can be turned to the uses of war or peace.

### The Compleat Letter Writer

WHEN the Extraordinary Grand Jury of the County of New York was investigating the curious charge made by Mayor HYLAN that the officers of the subway had conspired with their employees to induce them to strike last August, it was discovered that the Mayor's appeal to the striking men to put no faith in their employers but rather to rally round him was written in a certain familiar yellow-newspaper style. Persistent investigation brought out the fact that the manifesto was prepared for him by the city editor of WILLIAM RANDOLPH HEARST'S notorious New York *American*.

When Captain VON PAPEN of unpleasant memory left Nazareth in Palestine in great haste, owing to the advent of the British forces there, he left behind him a case known in naval parlance as a ditty box, which contained his papers. Among these were letters from his erstwhile companion in the United States, Kapitän zur See BOY-ED. In one of these BOY-ED recalled his manifesto to the American people which he issued on his enforced departure from these shores, and which reflected, to put it mildly, what he considered the unfairness of the public in regard to his precious activities—more particularly with firebugs and dynamiters. Most of our readers will recall a feeling of warmth about the neck on reading it. In a letter found in the box he explained to VON PAPEN, according to *The English Review*, that he had had the aid of SAMUEL UNTERMYER of the New York Bar in preparing the precious document.

Now we have no idea what meditations take place in Mayor HYLAN'S mind, because nearly three years' experience as citizens under his rule have proved this to be impossible. But in turning the matter over to the bureau of his friend HEARST he issued what was no less than an incitement to riot. And whatever excuse Captain BOY-ED may have thought to warrant him in his efforts at destruction, his expression resulted in one of the most remarkable and impertinent harangues ever offered to a justly offended people. And although in each case it was dirty work, it cannot be denied that both HEARST and UNTERMYER are men of unusual attainments and signal ability.

The point we want to bring out by these two examples of vicarious fulmination is that if one does not know what to say, it is better not to get somebody else to say anything. It pays to advertise, because the advertiser is sure to have an idea, and he is abundantly warranted in getting help to give his idea competent expression. But if he has only a grouch and is so angry as to be incoherent, there isn't any kind of ability that can translate his anger into reasonableness. The best HEARST'S man could do was to preach his employer's gospel of riot, and the best even SAMUEL UNTERMYER could do was to scold.

### Honorary Degrees In Chemistry

HONORARY degrees are very pleasant to receive, and once in a while a chemist gets one. The occasions are, however, rather rare. The University of Pittsburgh nearly every year confers the degree of Doctor of Chemistry upon some man of great achievement and distinction, but this, we believe, is the only institution in the United States that confers the degree at all. Otherwise such chemists as answer to the appellation "Doctor" without a disturbing twinge are usually Doctors of Philosophy, for which they have labored long, either here or abroad. Most German chemists also seem to be Doctors of Philosophy, and time was when, at all events at some universities, an "inaugural dissertation" on almost any subject was enough to pass them, while the oral examination was but little more than a formality. In other universities such doctorates required as much work as they do here. But the *mores* are different. Our technical schools, unless associated with a university, do not confer doctorates, and the great majority of chemists do not take them. Many of the



leaders in chemical thought in this country are undoc-tored. It has been proposed lately that certain colleges and universities could do a considerable service by setting aside, as it were, three honorary doctorates in science to be awarded to men resident in that state in which the institution is located, who have contributed important and distinguished work in chemistry or physics. This would require the appointment of a high commission consisting of three or four men of exalted standing in science who would recommend to the trustees the names of men entitled to such distinction. It would require, of course, that the trustees work in harmony with the commission appointed by them, and that politics be avoided. As soon as politics get into the thing the whole plan would be ruined. There is no Republican or Democratic science. But granted the proper appointment of such a commission, there is no reason why the plan should not work very well.

In the first place, it would add to the alumni of the conferring institution a body of men of science who, by their works, would do honor to it. Such alumni, being neighbors, would be disposed to contribute lectures and talks on scientific subjects to the inspiration of its students. It is fair to assume that such a commission would see to it that its candidates be men of worth in other respects, in addition to their achievements in science; but their scientific achievements would have to be genuine. It would bring the progress of chemistry and physics into the public eye and explain to the world why achievement in science is worthy of honor.

The title of Doctor, like that of Professor, has a variable application. In France a dancing master is a professor and here a chiropodist usually has the courtesy title of "Doc," but these are not official. There is a pleasant dignity to the title of Doctor of Science, as there is to that of Laws, and the plan to confer a limited number of these, *honoris causa*, to men who have achieved merit sounds reasonable to us.

### Steel Prices And Other Prices

THE steel industry has long distinguished itself for exhibiting kaleidoscopic changes. Now it outdoes itself in one respect. It eliminates time entirely and exhibits different phases at the same instant. "Declines in commodity prices" are being discussed by almost everyone, with all sorts of opinions expressed. A very reasonable opinion is that in the readjustment now occurring in the markets it is not chiefly a case of a horizontal reduction all along the line, but rather of readjustment, through improper alignments in prices having arisen. The net result of the whole thing may be a decline in the average of all prices, but the most pronounced changes will be in relations. One commodity may advance in relation to another commodity by remaining stationary while the other declines, or by declining less than the other.

Behold what the steel industry presents! One asks which commodities will remain stationary and which will decline. Does steel belong to the one class or the other? It does both. For months it has presented several different markets. There are a few men in the iron and steel business who have lived a longer business life than has the steel market, for excepting the part played by the bessemer rail many years ago steel as the dominant factor in the market for wrought ferrous products

is only between twenty-five and thirty years old. One of the old-timers, whose experience covered years of the old wrought iron or puddled iron market, remarks that never before had he seen the spectacle of there being more than one distinct market.

There is the Steel Corporation market, the Steel Corporation adhering rigidly to the Industrial Board schedule of prices which became effective March 21, 1919. On bars, shapes and plates the prices are respectively 2.35c., 2.45c. and 2.65c. Then there is the market of certain large independents, for delivery in say from two to five months, the prices being approximately 3c., 3.10c. and 3.25c. Finally, there has been a prompt or spot shipment market at prices much higher still, both bars and shapes having sold at 4.50c. in mill lots.

For some time the question was whether Mahomet would go to the mountain or the reverse. Should the prompt market continue, the Steel Corporation would have to advance its prices or become hopelessly over-sold, thus extinguishing itself as a market factor. Otherwise the prompt market would have to drop to a lower level.

Considering the great increase in the volume of money and credit since before the war, high wage rates and high costs everywhere, there can be no such thing as an early return, if there ever can be a return, to pre-war levels. One may conclude that some prices are not too high and that other prices are altogether too high. Illustrations can be found. For instance, comparisons of certain descriptions of hardware and tools, made from substantially the same raw materials and by substantially the same classes of workmen, show that some articles have advanced much more than others, when the change in cost of production must have been substantially the same.

If the highest prices are to come down and the lowest prices are to remain as they have been, this interesting steel industry is prepared. It has had three markets, all ready provided. The laws of economics, of supply and demand, of sentiment or whatever it may be that is to make the markets that are to come out of the present readjustment can take their choice of these steel markets, picking out the one that suits the conditions under which American business is to go ahead for the long pull.

The Industrial Board steel prices are about 80 per cent above the ten-year pre-war average of steel prices. That is quite moderate, considering that Bradstreet's last index number, for May 1, was 139 per cent above its ten-year pre-war average. Some steel, however, has sold within the past few months at about double the Industrial Board schedule, which would make it 160 per cent above the pre-war average, and that is obviously too high.

Pig iron, however, has made a market for itself, and it presents only one market. There is no notable delivery premium. While there is little if any business being done for far forward deliveries, the furnaces would not quote materially different prices from those lately ruling for early deliveries. Pig iron now stands between the low steel market and the high steel market. One would lose money buying pig iron at present prices and converting it into steel to be sold at Industrial Board prices, while he would make a great deal of money by selling at the highest steel market. Not having a collection of markets to select from, pig iron may have to make a new market to conform to whatever market the steel situation crystallizes into.

## Readers' Views and Comments

### Prolongation of German Patents and Useful Models

*To the Editor of Chemical & Metallurgical Engineering*

SIR:—Enclosed you will find an abstract of a letter from one of my German associates in regard to the prolongation of German patents and useful models. It may be of interest to your subscribers to know as soon as possible of the advantages offered by the new law.

A law has been passed rather abruptly by the German Nationalversammlung allowing the prolongation for five years of patents and useful models suffering from the war. Pending patent applications probably included.

Prolongation only on special motion to the patent office.

Term for filing the motion two months for patents and models already lapsed; six months for all other patents and models, beginning with May 14, 1920.

Motion to show the facts why the patent could not be exploited adequately during the war and prima facie evidence only to prove these facts.

No difference is made between German and foreign patentees.

Procedure before the patent office secret, no opposition from interested parties.

Rules for the execution of the law not yet issued.

The law is of a very liberal spirit, so that all patentees of German patents who were handicapped by the war should make use of it.

As to the lapsed patents, it is necessary to have the instructions to file motions at once, as an overcrowding of all patent attorneys' offices is sure to come very soon.

OTTO K. ZWINGENBERGER.

New York City.

### A Rapid Method for the Determination of Tin in Brass and Bronze

*To the Editor of Chemical & Metallurgical Engineering*

SIR:—The following method was worked out by the writer in an attempt to avoid the troublesome process of purifying the precipitate of metastannic acid by fusion with sodium carbonate and sulphur. The method is simply a modification of the well-known method for the determination of tin in ores. It has proven quite as accurate and much less troublesome than any of the gravimetric methods the writer has used.

Weigh out 0.5 to 5.0 g. of the sample (according to the amount of tin present) into a 250-c.c. beaker and dissolve in 10 to 25 c.c. of aqua regia. Dilute with water, heat to boiling and precipitate the tin with a slight excess of ammonium hydroxide. Filter off the precipitate of stannic acid and wash with hot water. Place a 500-c.c. Erlenmeyer flask under the funnel and dissolve the precipitate on the filter with hot (1 : 1) hydrochloric acid, washing the filter thoroughly with hot water. To the filtrate in the flask, add enough conc. hydrochloric acid to bring the total acid present in the solution up to 100 c.c. Dilute to 300 to 350 c.c., place a coil of pure nickel in the flask and boil for one hour, the flask being covered with a small watch glass. At the end of this time, remove from the hot-plate, drop in a small lump of marble or calcite and cool to room temperature or cooler. Remove the nickel coil, washing the adhering solution back into the flask, add a few c.c. of starch solution and titrate to a blue color with standard iodine solution.

The standard iodine solution is prepared by dissolving 11 g. of pure, resublimed iodine and 20 g. of potassium iodide in a little water and diluting to one liter. One c.c. of this solution is equivalent to approximately 0.005 g. of tin. The exact value of the solution is best determined by titrating a solution of pure tin.

As stannous chloride is quite readily oxidized, it is very important that the flask be kept full of CO<sub>2</sub> after removing from the source of heat in order to exclude the air. This end is quite satisfactorily accomplished by the use of marble or calcite, of which about 1 c.c. is usually sufficient. It should be completely dissolved when the solution is titrated. The writer has found that if care is exercised, the elaborate CO<sub>2</sub> generating apparatus described by some authors is entirely unnecessary for technical work. The operator should determine the amount of iodine necessary to give an end point with a solution containing no tin and should deduct this blank from each burette reading.

The nickel coil is made by cutting a strip about 1 in. wide from a sheet of pure nickel foil about  $\frac{1}{8}$  thick and rolling it into a coil small enough to pass easily through the mouth of the flask. This coil is removed from the solution by means of a nickel wire about 6 in. in length and having about  $\frac{1}{4}$  in. of one end bent at right angles. The other end may be fused into a length of glass tubing which serves as a handle.

The titration should be performed as rapidly as possible to avoid oxidation by the air. There are no interferences when the solution is cooled below 40 deg. C., though the copper, if left in the solution, obscures the end point.

The acid strength of the solution should be at least 25 per cent by volume.

L. R. RAYMOND.

Flat River, Mo.

### Industrial Alcohol Regulations

*To the Editor of Chemical & Metallurgical Engineering*

SIR:—I am pleased to forward you the following changes which have been made in the formulas for specially denatured alcohol, since the publication of my article on them in your issue of March 17, vol. 22, No. 11, pp. 513-518.

Formula 25 has been changed so that it is now composed of 100 gal. of ethyl alcohol, 20 lb. iodine and 15 lb. potassium iodide.

Formula 34 has been authorized, which consists of 100 gal. of ethyl alcohol and 5 gal. of tetrachlorethane. This formula is authorized for use in the manufacture of artificial silk.

Formula 35 has been authorized, which consists of 100 gal. of ethyl alcohol and 35 gal. of ethyl acetate. This formula has been authorized for use in the manufacture of acetparamidophenolsalol.

These formulas, you understand, are specially denatured alcohol and are subject to supervision as to distribution and use by the U. S. Internal Revenue Bureau.

B. R. TUNISON.

U. S. Industrial Alcohol Co.  
New York City.



## Separation of Fixed Oils From Soap-Water Emulsions

A Study of the Phenomena Exhibited by Emulsions of Oils in Aqueous Soap Solutions—Classification of Emulsions—Effects of Dilution, Salting and Various Physical Forces and Their Possible Application in Oil-Recovery Processes

By EUGENE E. AYRES, JR.

THE following discussion of emulsions of oils and soap-waters is not based upon any purposed and consecutive research, nor is any reference made to the rather copious literature. Each year the writer comes in contact with hundreds of men, each keenly intent upon some emulsion problem. To ninety-nine out of each hundred the science of colloids and of physical chemistry is exceedingly vague, and yet these men are often successful in solving their problems. They work in the dark, and they are to that extent handicapped, but often the freshest ideas come from those whose points of view are naïve. The following discussion is an attempt to analyze and interpret the collective observations of these "practical investigators."

It is convenient at the outset to make several reservations. Only the types of emulsions encountered in industrial manufacture are included in this discussion. Naturally, it has not been attempted to completely cover the types of practical importance. Zinc and lime soaps, for example, or rosin soaps, or the "soaps," so called, derived by neutralization of organic acids in petroleum, or the soaps of volatile fatty acids—none of these cases is discussed. By "soap" is meant the caustic alkali soaps of the common higher fatty acids. Similarly, the sulphonated fatty compounds and the amides of fatty compounds have been ignored.

### CLASSIFICATION OF EMULSIONS

Simple emulsions of oil and water may be classified as

1. Those in which water is suspended in oil, and
2. Those in which oil is suspended in water.

Many industrial emulsions are not "simple," but may be technically classed as "complex." A complex emulsion is one in which the dispersed liquid does not consist merely of globules of oil or of water, but in which the suspended globules are themselves emulsions with tiny globules of liquid suspended in them.

Some emulsions are much more complicated in structure than this, especially when suspended particles are ultra-microscopic, but our definition of "complex" emulsions has the advantage of serving our purpose without confusing the issue.

We may make a complex emulsion of the mutually insoluble liquids A and B. The bulk of the mixture is A. The globules suspended in A consist primarily of B, but still smaller globules of A are suspended in each globule of B. A concrete illustration is found in the emulsion obtained when a saponifiable oil is warmed and agitated with a solution of caustic soda sufficient in amount to saponify only a small proportion of the oil. The oil is the A liquid, and the aqueous soap solution is the B liquid. An example of the opposite type is formed when crude petroleum is thoroughly agitated with two or more volumes of water. Here water is the A liquid, while oil is the B liquid.

A "saturated" emulsion is one in which the globules are packed together as tightly as possible in the space provided by the continuous liquid. If small spheres of uniform size are crowded into a given space, the volume taken up by the spheres will be a definite percentage of the volume of the given space. This percentage is independent of the size of the spheres. But if, in such a system, we should insert smaller spheres in the spaces still available, the percentage will be higher. Mathematically speaking, the function is a variable which approaches but can never reach a limit of 100 per cent. The emulsions met with in practice always contain globules of various size—some larger, and some smaller than average. But industrial emulsions rarely contain more than 50 per cent of the dispersed phase. The writer has never seen an industrial emulsion containing more than 80 per cent of the dispersed phase.

A "dilute" emulsion is obviously one that contains only a small percentage of dispersed liquid. To "concentrate" an emulsion is to separate from a dilute emulsion as much of the continuous liquid as possible, leaving a saturated emulsion.

Concentration of dilute emulsions is practiced commonly in many industries.

### SIMPLE AND COMPLEX OIL-SOAP-WATER EMULSIONS

While the definitions suggested above are still fresh in mind, consider the soap-water emulsion as a type. If the emulsion is simple, the aqueous soap solution is the continuous liquid with the oil suspended as globules. If the emulsion is complex, the oil is continuous with suspended globules of simple emulsion wherein water is continuous. The writer has seen no exceptions to this rule. If we were to take, for example, a liter of oil and agitate with one c.c. of soap solution, the emulsion would be invariably complex. As the oil is present in such large proportion, the oil is obviously continuous. If the suspended soap-water is separated (say by gravity settling), it will be found that oil globules are suspended in the soap-water unless gravity has also separated the simple emulsion. There are few cases where soap-water can be completely freed from suspended oil globules by subsidence (gravity or centrifugal), while it is a general rule that the continuous oil of a complex emulsion can be freed with relative ease from the suspended emulsions by subsidence.

Take the converse example of one liter of soap-water with one c.c. of oil. This emulsion will always be a simple emulsion.

If an emulsion of oil and soap-water contains more than 80 per cent oil, it is reasonably safe to conclude that the emulsion is complex. If the oil content is below 20 per cent, the emulsion must be simple. The range between 20 and 80 per cent may belong to either

class, but in nearly every case up to 50 per cent it will be found that the emulsion is simple.

Without recourse to microscopic examination it is easy enough to determine whether oil or water is continuous in an emulsion. If the emulsion is miscible with water, water must be the continuous phase of the emulsion. If oil is continuous, the emulsion will be miscible with oil. Of course, there are cases of true emulsoids where we find miscibility with both oil and water, but this discussion has nothing to do with such cases. The true emulsoid must be ruled out forthwith.

For industrial emulsions, a convenient test is to pour a few drops of the emulsion into a beaker of water. If the emulsion diffuses through the water, water must be continuous in the emulsion. In the case of a soap-water emulsion, the investigator may draw one other inference—the emulsion is simple, with suspended globules of oil. If the emulsion does not diffuse through the water, oil is continuous, and in the case of soap-water emulsions, the emulsion is complex with suspended globules of simple emulsion.

#### SUPER-SATURATED EMULSIONS

There are what may be termed "super-saturated" emulsions, which may be described as imperfect mixtures of oil with a simple saturated emulsion. The excess oil is not present in sufficient amount to form a primary continuous phase, and this oil is not globular. Such a mixture is possible only when the emulsion is of high viscosity, for otherwise this excess oil would immediately separate. In the diffusion test, the presence of such oil is indicated by a diffusion of the emulsion proper while the excess oil remains on the surface of the water.

Super-saturated emulsions are very common in the industries, but inasmuch as the recovery of the excess oil is so simple a matter, no reference to super-saturated emulsions will be hereafter made.

#### PERSISTENCE OF EMULSIONS

The continuous oil may be most easily separated from a complex soap-water emulsion when the aqueous phase contains a high concentration of soap. For this reason, when a rancid vegetable oil is refined with caustic soda, it is desirable to employ a caustic soda solution of high strength. Weak caustic soda solutions tend to give complex emulsions in which it is difficult to produce a "break," with subsequent settling of simple emulsion. The strength of caustic soda solution is limited only by refining conditions that have nothing to do with emulsion stability.

Simple soap-water emulsions may contain oil globules of two sorts:

- (1) Globules that are "fixed"—that will remain intact as globules until something happens—chemical or physical—to unite them, and

- (2) Globules that are temporary—that have been formed by agitation, precipitation or what not, and that will unite to form larger globules that yield readily to subsidence.

The only requirement for the agglomeration of these "temporary" globules from the soap-water is sufficient elapsed time. To agglomerate the "fixed" globules without chemically changing the character of the soap-water is an extremely difficult matter. The writer knows of no instance where such agglomeration is accomplished on a large scale. It is common practice to allow an emulsion to stand in a tank or to pass through a high-

speed centrifugal to skim off the oil that can be so separated. But some oil is left behind, and additional subsidence fails to separate it.

#### CHARACTER OF OIL AND SOAP SOLUTION IMPORTANT

What governs the percentage of oil removable and of oil fixed? The biggest factor is the character of the oil. In general a glyceride of a fatty acid has a much higher "fixed concentration" than a liquid hydrocarbon. It is possible to incorporate permanently more olive oil than lubricating oil with any given soap solution. But there are some miscellaneous oils and greases and waxes of vegetable or animal origin that give a higher fixed concentration than the fatty acid vegetable and animal oils and fats. Examples may be found in certain constituents of wool grease and in the organic "impurities" in crude vegetable oils. The fixed concentration of any commercial oil as a whole is much the same as the fixed concentration of its worst component. For instance, a little linseed oil dissolved in kerosene will raise the percentage of permanently emulsified impure kerosene almost to the value of linseed oil itself. The trace of organic impurity in crude cottonseed oil makes the latter an easily emulsified oil.

In many cases the fixed concentration is coincident with the saturation point. This is not true of any pure glyceride and even less of any pure hydrocarbon.

Next in importance among the factors involved in fixed concentration is the character of the soap solution. This involves soap concentration, the kind of soap, alkalinity, electrolytes and protective colloids. The lower the soap concentration and the alkalinity, the lower the percentage of permanently emulsified oil. The effect of alkalinity on emulsions of easily saponifiable oils may not be readily noted because of saponification reactions. The effect of electrolytes is erratic and will be discussed later. Soluble electrolytes are of course limited to salts of metals of unit valence because of the insolubility in water of soaps of metals of higher valence. Little difference has been noted between various pure soaps, but commercial soaps differ because of the effect of non-fatty-acid impurities. A trace of a water-insoluble soap (zinc or calcium) may or may not increase the fixed concentration.

The fixed concentration is not greatly influenced by temperature.

#### STABLE EMULSIONS

When all "temporarily emulsified" oil has been permitted to agglomerate and separate, the residual soap-water emulsion at its fixed concentration of dispersed oil is regarded as a stable emulsion. The stability is of two kinds:

- (1) A resistance to agglomeration, or the merging of globules (with accompanying subsidence) to form a continuous oil phase; and

- (2) A resistance to a concentration of the emulsion, or the subsidence of globules intact to produce on the one hand a saturated emulsion, and, on the other hand, soap-water with appreciably less oil in suspension.

The stability of emulsions is regarded as a phenomenon of surface tension, and reactions that affect surface tension will likewise affect stability. But it is an odd fact that reactions which diminish the tendency for globules to maintain their uniform distribution throughout the soap-water medium will usually increase their resistance toward agglomeration. The conspicuous example of this interesting effect is found in



soap-water emulsions of increased alkalinity. The higher the alkalinity (caustic soda or normal sodium carbonate, for instance), the less likely we are to succeed in breaking down the globular formation to obtain continuous oil, but the more likely we are to concentrate the globules intact to form a saturated emulsion. Generally speaking, it is much more difficult to agglomerate in a soap-water emulsion than it is to cause a separation by subsidence of globules. It is believed that this is a highly important item to keep in mind. Chemists have been too often accustomed to measure the success of an expedient for separation by the yield of free oil without taking into account the changes that may have taken place in concentration. This naturally arises from the fact that oil is easily recognized from appearance, while emulsions more or less concentrated look much the same. As a case in point, we may quote the following procedure:

A certain soap-water emulsion contained 10 per cent of oil at its fixed concentration. On standing for ten hours, samples of the emulsion from the surface and from the bottom analyzed a uniform oil percentage (because the viscosity was too high for appreciable gravity subsidence in the allotted time). One per cent of caustic soda was added. After standing one hour, no free oil had appeared, but the liquid at the bottom was relatively clear, while the supernatant liquid was thick and opaque. The clear soap-water was drawn off and tested. It contained less than 0.5 per cent oil. The concentrated emulsion was mixed with a quantity of 1 per cent aqueous solution of caustic soda equal to the soap solution withdrawn, and settled again for one hour. No free oil appeared, but a subsidence of globules again took place. After a third similar treatment, the concentration of emulsifying agents had been reduced to such a low point by the successive dilutions that the globules agglomerated and a fairly complete yield of continuous oil was obtained.

Needless to say, such a procedure is impractical for saponifiable oils because of losses of oils by saponification. But though, for this reason, yields are necessarily low, separation is almost as effective as with unsaponifiable oils, in spite of the maintenance of a relatively uniform soap concentration (by saponification). This is because a high fixed concentration is not possible with pure glycerides and soaps, and involves the presence of impurities.

In the commercial soap-water emulsion, the most common emulsifying agent is material that, although unsaponifiable (in the sense that fatty acid soaps may not be formed), is clearly acted upon by alkalis to form a substance colloiddally "soluble" in water. These substances are regarded as "protective colloids." There are a number of protective colloids that either do not occur commonly, or else are so invariably associated with unsaponifiable greases as to lose individual significance. Such substances are glue, gelatine, albumen, lecithin.

#### TEMPORARY GLOBULAR DISPERSION

To refer again to the "temporarily" emulsified globules, when agglomeration and attendant subsidence have proceeded as far as possible under the influence of gravity, an application of high centrifugal force will not cause additional agglomeration. A force higher than gravity will cause a correspondingly more rapid subsidence of agglomerated "temporary" globules, but the fixed concentration remains the same.

Similarly, an emulsion at its fixed concentration (or below) is favorably affected in one way by high centrifugal force—the subsidence of globules is more rapid. It is an interesting fact that the only variable in practice is in the rate of concentration. If the force is increased or diminished, the rate of concentration is correspondingly increased or diminished, but the residual emulsion is likely to be neither more nor less dilute, and the concentrated emulsion is likely to contain neither more nor less oil. In other words, for any given emulsion, the eventual yield is practically constant if the time during which centrifugal force (or gravity) is allowed to act is commensurate with the force applied. In order to increase the rate at which this yield may be obtained, it is sufficient to increase the force, but to increase the yield we must change the emulsion itself.

There is but one change that will increase the yield, and that is an increase in the size of the globules that remain in the dilute residual emulsion. In our use of the word "agglomeration" we have heretofore implied the union of globules to produce a continuous phase. However, agglomeration does not necessarily imply the production of a continuous phase. Almost any physical or chemical change in an emulsion will cause a change in the average and the minimum size of suspended particles, and this change is brought about by the union of several globules or else the splitting up to form smaller globules. It is only under peculiarly favorable circumstances that the change will go all the way to the limiting conditions of continuous oil on the one hand or "soluble" oil on the other hand. Ordinarily the change proceeds only part way—the globules become a little larger but they remain globules, or the globules become smaller but do not approach near enough to molecular dimensions to yield a transparent emulsoid.

#### ELIMINATION OF PROTECTIVE COLLOIDS

The most important factor in securing this partial agglomeration is a reaction to destroy the effect of the protective colloid. The reaction may not destroy the colloid itself, but it is sufficient to throw the colloid out of aqueous solution either by precipitation or extraction. Extraction may be accomplished by rendering the colloidal substance soluble in the oil of the emulsion. An impurity in the oil phase of a soap-water emulsion does not act as protective colloid. Agitation (within reasonable limits) tends rather to increase than to diminish the size of globules in a soap-water emulsion—an effect comparable to the production of butter from cream by churning. The addition of water will increase the size of the smallest globules.

The simplest chemical methods of causing agglomeration are based on the tendency of weak acids to "decompose" the alkaline protective colloids without splitting the soap. Carbon dioxide and boric acid are examples. The impurities when acidulated dissolve in the oil and thus greatly reduce the stability of the emulsion. It is natural to expect that the oil, when finally recovered, will be tainted with these impurities.

Any treatment based upon the elimination of the protective colloid is likely to be limited in its efficiency to the fixed concentration of the pure oil with a pure soap solution.

A condition that reduces the degree of dissociation of soap in solution will still further increase the yield of oil. As an example of such a condition the laboratory test may be cited where alcohol is added to a soap-water

emulsion to facilitate the separation of a petroleum-ether extraction.

#### GELATINOUS EMULSIONS PERSISTENT

Commercial soap-water emulsions commonly tend to gelatinize. Pure soap solutions will gel when the soap concentration is high enough, but the gel is rather unstable—a little addition of water or a moderate elevation of temperature is likely to destroy the gel to form a liquid of relatively low viscosity. The gels formed by many commercial soap-water emulsions are more stable. The emulsion is likely to retain its gelatinous character even after considerable dilution with water or the application of boiling temperatures. The stability of the gel appears to be largely influenced by the proportion of protective colloid present, for the non-fatty-acid greases in alkaline aqueous solution form persistent "semi-gels" not so rigid as a pure soap gel but much more stable. The impure industrial emulsion when gelatinous usually has this same persistent semi-gelatinous consistency.

The gelatinous character of an emulsion must be regarded as important in view of the fact that agglomeration to form a continuous oil phase and concentration of globules to form a saturated emulsion is impeded by high viscosity. The viscosity of these "semi-gels" is gradually reduced as the temperature is raised, but even when boiling, the emulsion is likely to retain gelatinous characteristics. The semi-gel can be truly liquefied only by dilution with water or by chemical action. When sufficient water has been added to eliminate gelatinous characteristics, the viscosity of the emulsion is not greatly influenced by temperature changes. The diluted emulsion will usually remain liquid under any circumstances of physical change, though a chemical change (such as that induced by the addition of a little salt) is likely to throw the emulsion back into the semi-gelatinous state. Conversely, when it is attempted to liquefy a gelatinous emulsion by chemical means (instead of dilution with water), the liquid state is likely to be quite unstable, and a reversion will occur with almost any physical change, such as heating or cooling, agitation, addition of small amounts of water, etc. The addition of a trace of mineral acid to a gelatinous emulsion will often cause liquefaction. A little agitation will restore the gel. Another trace of acid again liquefies, and another agitation again causes reversion. This cycle may be repeated until the soap is nearly or completely decomposed.

A complex soap-water emulsion is rarely gelatinous, for the dispersed phase, when gelatinous, will readily settle out, yielding the excess of oil and the simple emulsion.

#### EFFECT OF DILUTION

Unless carefully prepared, a gelatinous soap-water emulsion will not contain its oil as suspended globules because the viscosity of the continuous soap solution is too high to permit interfacial surface tension to act. The oil will be in irregular streaks or strata. As soon, however, as the emulsion is liquefied by dilution or by other means, the oil assumes its globular form. In one sense, dilution reacts unfavorably on separation procedures, for dilution increases the stability that resists agglomeration. A gelatinous emulsion that will slowly yield up some of its oil in continuous form by agglomeration and subsidence will not yield this oil after dilution. In other words, some of the oil that is

"temporarily" emulsified in the gel assumes the state of fixed globules when water is added. To reduce the percentage of oil permanently held up in gelatinous emulsions has been the subject of many a research.

It has been stated that when the concentration of soap, alkali and protective colloid is reduced, the fixed concentration of emulsified oil will be reduced. Whether or not dilution will cause a separation of oil from an emulsion depends, obviously, upon the mathematical structure of the function involving the variables of dilution and fixed oil percentage. To illustrate, suppose we take an emulsion which contains 10 per cent soap and 20 per cent fixed oil and 70 per cent water. The actual concentration of substances in the aqueous phase will therefore be 14.3 per cent soap, and 28.6 per cent oil. To 100 g. of this emulsion we add 70 g. water. The soap and oil concentrations will be cut in half—7.15 per cent soap and 14.3 per cent oil. If 14.3 per cent represents the fixed oil concentration for this diluted emulsion, we can recover no oil. If the fixed oil concentration is below 14.3 per cent, we can recover some oil. Suppose the value is 10 per cent. The fixed oil in grams will amount to 17. Our recovery will be 3 g., or 15 per cent of theoretical.

Often the fixed concentration will be reduced by larger differentials than the soap concentration up to a certain point beyond which the relation is reversed. The following table illustrates one case. The emulsion was composed as in the above paragraph. The emulsion was progressively diluted, and subjected to a given centrifugal force for a given period. The oil not recovered was regarded as "fixed."

Percentage of Aqueous Phase Soap Per Cent	"Fixed Oil" Per Cent	Percentage Recovery Per Cent
14.30	28.60	0
7.13	10.10	15
4.80	5.40	35
3.55	1.95	70
2.80	4.10	25
2.40	4.80	0

The above is an unusual case in that the dilution yielding maximum recovery is so low.

#### RECOVERY OF OIL BY ACIDULATION

The common method in our industries of recovering oil from soap-water emulsions is to acidulate. The acid reacts with the soap to produce fatty acids and the acid reacts also with the unstable alkaline organic impurities (when these are present). The impurities when acidulated are no longer protective colloids, but are usually quite soluble in oil and in fatty acid. When a commercial soap-water emulsion is acidulated, therefore, the recovered material consists of the mutually soluble oil, fatty acid and certain organic impurities that may have been present in colloidal solution in the soap-water. We have seen one case in which the alkali-soluble non-fatty-acid material comprised more than 20 per cent of such an acidulated mixture.

The subsidence of the water-insoluble materials upon acidulation is usually rapid and complete because there exists no longer any soap or any alkaline protective colloid to stabilize the emulsion. Occasionally we run up against stubborn emulsions of fatty acid with dilute mineral acid, but these emulsions are totally different from the soap-water emulsion which constitutes the present subject for discussion. In cases where there is a tendency to form stable fatty-acid emulsions by the acidulation of soap-water emulsions, the stability depends very largely upon the physical conditions under which the acidulation is conducted. This is particularly



true when the alkali-soluble impurities form oil-insoluble solids when acidulated (wool-scouring liquors).

When it is considered satisfactory to obtain the mixture of oil, fatty acid and impurities, the acidulation of a soap-water emulsion is the obviously correct procedure—inexpensive, complete in yield and uniform in operation. The major reason, in fact, that acidulation is considered unsatisfactory is that methods of separation of oil, fatty acid and non-fatty-acid grease, each free from the others, have not received sufficient attention from chemists. The recognized methods for such a separation have involved new soap-water emulsions and yields are negligible.

#### SALTING OUT PROCESSES

It is common knowledge that salt tends to throw soap out of aqueous solution. The higher the salt concentration the more complete will be the precipitation. Solutions of the soaps that are most easily salted will dissolve salt in low concentrations, without any actual precipitation. These low salt concentrations are interesting. Suppose we take a stable emulsion and add enough salt water to bring the salt concentration to 0.5 per cent of the aqueous phase. The usual effect will be the increase of stability. It will be more difficult to agglomerate globules or to concentrate globules without agglomeration. When a high concentration of salt is used, the soap will be thrown out of solution, and the oil may or may not be recoverable. This point is enlarged later on.

#### BREAKING AN EMULSION WITHOUT PRECIPITATING SOAP

But there is a certain point in salt concentration where a soap-water emulsion may be completely broken without an actual precipitation of soap, and the oil may be recovered as a continuous phase. It is believed that every soap-water emulsion (if not too viscous) will yield up some of its oil if exactly the right percentage of salt is carefully added, but the procedure is likely to remain an impractical laboratory curiosity on account of the difficulty in formulating any rule by which the correct salt percentage may be estimated. A series of tests on three commercial samples of cottonseed oil soap-water emulsions of nearly the same constitution in oil, soap and water gave the following salt concentrations as necessary for oil recovery—2.1 per cent, 3.6 per cent, 1.2 per cent. These concentrations are based on the water content of the emulsions. In each case when the salt concentration was increased or decreased by a few tenths of 1 per cent, the stability of the salted emulsion appeared much the same as the stability of the unsalted emulsion. This sensitiveness appears to be linked with the tendency for a soap-water emulsion to gel with slight provocation of chemical change. There was no gradual relationship between oil yield and salt concentration, but a sudden change at one definite point.

Moreover, there seemed to be no functional relationship between this point and the percentage of major constituents in the emulsion. A careful research would probably show that the critical salt concentration required to bring about this change is a somewhat complex function of all constituents—in particular the proportion of impurities that constitute the protective colloids. It would be helpful if a simple analytical determination could be devised to show what might be termed "effective alkalinity." Because of hydrolysis, soap solutions are always alkaline; but the alkali is

often more loosely combined with the protective colloid than with fatty acid, so loosely, in fact, that it is possible to completely saponify a fixed oil in such an emulsion by the addition of normal sodium carbonate, which appears to displace the caustic alkali from the impurities. The protective colloid acts as a catalytic agent in a saponification of this sort. The non-fatty-acid organic material in colloidal solution may sometimes be extracted from an alkaline solution with ethyl ether or benzol.

#### THE CRITICAL SALT CONCENTRATIONS

The effect of low salt concentrations on one emulsion is shown in the accompanying curve, (Fig. 1), wherein

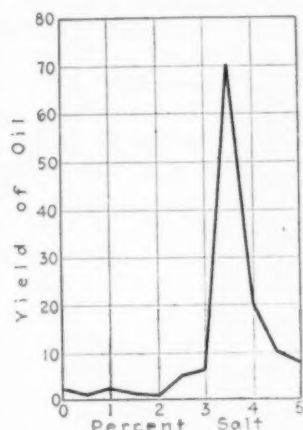


FIG. 1. CRITICAL SALT CONCENTRATION

salt concentration is plotted against yield. The emulsion contained 75 per cent of a 25 per cent soap solution and about 20 per cent oil, with about 5 per cent alkali-soluble impurity. The yield figures represent the percentage of oil recovered as free oil based on a theoretical yield of 100 per cent, by subjecting the emulsion to high centrifugal force for a given period. The critical salt concentration is not nearly so sensitive with emulsions of cocoanut oil soap because this soap is more soluble than others in salt water. To revert to high salt concentrations, when soap is "salted out" the precipitation may occur in one of two ways—with a film of oil adhering to the soap particle, or with a similar film of water. When a salted emulsion is permitted to stand, or is centrifuged to permit immiscible layers to form, the salt water will be found at the bottom, the oil at the top and the soap particles intermediate. The soap layer is not a liquid layer, but a mass of solid particles with interstices occupied by liquid. Whether this liquid be oil or water will depend upon the character of the precipitation—whether the particles are enveloped by films of oil or of water. The settled system may therefore be considered as composed of only two layers—oil and water—with the soap sludge either in the upper portion of the water or else in the lower portion of the oil. (See Fig. 2.)

It is clear that the yield of oil from such a separation is dependent upon the position of the soap sludge. It is highly important that the salting out be accomplished in such a manner as to suspend the soap in salt water. Unfortunately, no generally correct rules can be given here for a proper salting out. The writer has often been unable to secure an aqueous precipitation with some emulsions under any conditions. On the other hand, with other emulsions it has been found an easy matter to so alter the conditions of precipitation as to obtain the soap sludge either in the water or in the oil. An emulsion in which the ratio of oil to soap is high is particularly favorable to the aqueous suspension of the soap. The lower the soap concentration in the aqueous phase, the more likely the soap may be precipitated in the aqueous phase. The higher the concentration of protective colloids, the more likely the soap will be precipitated in the oil phase.

Often when an emulsion contains a high ratio of

soap to oil and an oil recovery by salting out appears impractical, it is feasible to concentrate the emulsion (after appropriate dilution) by gravity or preferably by centrifugal force and to salt out the saturated emulsion. The saturated emulsion contains more oil, less soap, and less organic impurities than does the original emulsion. But unless the soap and protective colloid concentration has been very materially reduced, it is necessary to dilute the saturated emulsion with fresh water to obtain a good yield of oil. The dilution aids the aqueous soap precipitation. When fresh water is added to an unsuccessfully salted emulsion the aqueous phase is diluted, but the soap still remains in the oil phase. In other words, the soap particles remain enveloped by the liquid originally in contact, no matter what changes are made *after precipitation*.

Any proper discussion of correct procedure for the addition of salt to a soap-water emulsion would lead us into the general problem of reactions between immiscible liquids. Such reactions are common in our industries, and the problem would seem to offer an interesting opportunity for further speculation and research. It is sufficient to remark here that emulsions sufficiently low in soap and organic impurities can be satisfactorily salted out by the addition of solid salt, if at least 30 per cent water is present in the emulsion. For water contents as low as 25 per cent, better results are secured by agitation with a saturated salt solution. For lower water contents, it is advisable to obtain a more thorough emulsification of brine with soap-water emulsion than can be ordinarily obtained with a stirring arrangement. A high velocity nozzle or a centrifugal emulsifier will accomplish this purpose.

If an emulsion is complex (i.e., contains some continuous oil), a dilution with fresh water will not greatly improve salting out conditions. Whether or not water is added to such an emulsion, a severe mechanical emulsification with brine is recommended.

The above data relate to sodium chloride. Other neutral salts of unit positive valence act similarly but in different degree. Sodium sulphate, for example, although not as effective as sodium chloride in the salting out of soap, accomplishes in general much the same results. A very low concentration of sulphate tends to stabilize an emulsion. Sodium sulphate has also its critical concentration where the emulsion is broken without soap precipitation, but the curve is apparently not as sharp as the curve shown for common salt. The writer has not noted the specific effect of high concentration of sodium sulphate.

When a simple soap-water emulsion is chilled to a point where the continuous water is frozen, some of the emulsified oil is likely to agglomerate and separate

after cautiously melting. This effect has been found to occur in cases of gelatinous emulsions high in soap and oil. The best method of freezing, the best methods of melting, the limiting conditions of emulsion composition and the yields obtainable under correct conditions are not known to the writer.

Simple emulsions of coconut oil give an opportunity of observing the opposite phenomenon. At normal temperatures the suspended oil is solid. No agglomeration of practical interest appears to occur when such an emulsion is alternately warmed and cooled except in cases of saturated emulsions, when a partial recovery may be made.

A mention of electrical separation methods will be in order.

#### ELECTROSTATIC ACTION

The various processes for a.c. and for d.c. current at high and low voltage, developed during the past decade for the separation of emulsions of water with crude petroleum, have proved highly successful in this field where large volumes must be handled at low costs (a few cents per barrel). Different investigators have ascribed different theories for "electrical precipitation," but from the nature of the processes one thing is self-evident—the action depends upon the dielectric property of petroleum, which is invariably continuous in these emulsions. The suspended water is affected by the current in such manner as to cause agglomeration and subsequent subsidence. If an aqueous phase were continuous, the current would be immediately short circuited, and there could be no conceivable agglomerating effect on the suspended dielectric oil.

Unless some entirely different method of electrical precipitation is developed, there would seem to be no possibility of separating oil by this means from a simple soap-water emulsion. On the other hand, there would seem to be no reason why the suspended emulsion in a complex soap-water emulsion could not be precipitated advantageously by means of a modified form of one of the present types of electric treater, because, in this case, the oil constitutes the primary continuous phase.

Perhaps some enterprising refiner of vegetable oils will some day develop an electrical system whereby an "off crude" may be refined with high yield.

In conclusion, we would call attention to an aspect of the soap-water emulsion problem that must be regarded as extremely important and that would require for proper discussion as much space as we have allowed for this entire article. When salts of multiple positive valence are added to a caustic alkali soap-water emulsion, a reaction takes place between the salt and the soap. The products of this reaction determine the stability of the emulsion.

We have attempted to describe and to define a viewpoint. The really difficult step in the development of a colloidal process is to interpret the problem and when an acceptable interpretation is forthcoming, it is not so difficult to find a satisfactory mode of operation. We believe that some of the data given above is rather more than less correct when applied to cases which we have specifically excluded. But if these data are regarded merely as an interpretation, you will not place any mistaken dependence upon what may have been expressed as a formula or rule. Each problem has its peculiarity, and generalizations are so infrequent that each specific case is likely to add to the sum of interesting but difficultly classifiable information.

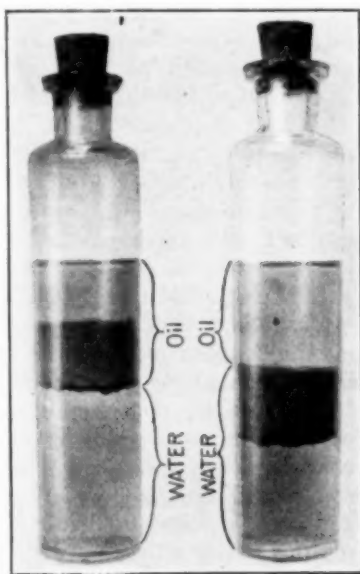


FIG. 2. SOAP PRECIPITATED IN THE OIL AND WATER PHASES



# The Acid Open-Hearth Process for the Manufacture of High-Grade Steel\*

A Description of the Acid Open-Hearth Process Used at the Midvale Steel & Ordnance Co.'s Nicetown Works, and of the Conditions Conducive to the Successful Manufacture of High-Grade Steel

By B. E. L. DEMARÉ

**I**N A broad sense, any steel which in a perfectly satisfactory manner serves the purpose for which it is intended may be considered high grade. In the more narrow sense, however, in which it is here used, it may be defined as a steel which, to be accepted, must pass certain more than ordinarily severe tests, where the margin between success and failure is so narrow and the financial loss by failure so great that the steel maker is not only justified but compelled to leave nothing undone which in any possible way may improve the quality of the steel, regardless of quantity or of any reasonable increase in its cost of manufacture, in order to insure a high percentage of acceptance when the steel is finally submitted to the test.

## PRODUCTS FROM ACID OPEN-HEARTH STEEL

The more important products of acid open-hearth steel, manufactured by Midvale, are as follows:

1. Armor-piercing projectiles,
2. Gun forgings, especially of large caliber,
3. Large or intricate forgings, such as marine crankshafts and connecting rods, bucket wheels and pinion shafts for steam turbines, and other forgings, in which transverse strength is required,
4. Forgings which require a hard and polished surface without flaw or blemish, such as hardened rolls,
5. Special grades of bar steel,
6. Locomotive and car-wheel tires.

The order in which the above classes have been enumerated may be considered as indicating the relative severity of the acceptance tests they have to pass, and therefore the relative degree of quality required, the armor-piercing projectiles requiring the highest quality, with gun forgings a close second, and so on.

## ACCEPTANCE TESTS

The test required for the acceptance of projectiles is as follows: From each lot of 500 projectiles four are selected to be fired against a face-hardened armor plate at a certain velocity and angle of impact, of which two must pass through the plate and remain in effective bursting condition. Should this test be a failure, four more projectiles may be selected and fired, of which three must pass through the plate and remain in effective bursting condition. In the case of 16-in. shells, the cost to the contractor of this second test would amount to about \$20,000. Should it fail, the whole lot of 500 projectiles may be condemned; or the contractor may be permitted to re-treat it and re-submit it as a new lot, which would entail an extra expense of approximately \$100,000. It is thus evident that every possible attention must be paid to the quality of this steel in

order to avoid great financial loss, as well as loss in reputation.

## TEST FOR FORGINGS

The chief tests for acceptance of gun forgings are of the tangential test bars taken from the breech and muzzle ends of the rough-machined forgings. As specified, these shall be located with their axes in planes perpendicular to the major axis of the forging, and also with their axes perpendicular to the radii, which pass through the middle points of the lengths of the bars, and for larger gun forgings are to be taken, one from the outer, two from the middle and one from the inner section of wall at each end of the forging. The contractor will be allowed three official tests only. Where the test specimens fail to meet the requirements on the third submission, the piece shall be finally rejected, with certain exceptions.

The minimum physical qualities of nickel steel gun forgings of 3-in. caliber and above are as follows:

	T. S. lb. per sq. in.	E. L. lb. per sq. in.	Elong. Per Cent	Contr. Per Cent
Tubes and liners	90,000	55,000	18	30
Jackets	90,000	60,000	18	30
Hoops	95,000	65,000	18	30

Other causes for rejection of gun forgings are ghost-lines, where careful examination shows any lack of continuity of the metal, slag pockets and sand splits, or cavities containing particles of slag, etc., if, in the opinion of the inspector, they are serious enough. Bearing in mind that the present standard 16-in. 50-caliber Navy rifle is built up of forgings made from ingots up to 63 in. octagon in section and 200,000 lb. in weight, the importance of taking every possible care to avoid defects liable to cause their rejection may be appreciated.

What has been said of gun forgings applies in greater or less degree to the forgings mentioned in class 3, especially where transverse strength is required, as determined by transverse or tangential test bars.

## TESTS FOR OTHER CLASSES OF ACID OPEN-HEARTH STEEL PRODUCTS

As regards the fourth class, such as hardened rolls, the difficulty with them is that after having been forged, annealed, machined, hardened, ground and polished, if then a careful inspection should reveal any imperfection in the polished surface, such as a small oxide or slag spot, hardly visible to the naked eye, this would condemn the roll as being unfit for its purpose.

In the remaining two classes, No. 5, special grades of bar steel, and No. 6, locomotive and car-wheel tires, we approach the borderland, where the acid and basic open-hearths compete, and where, except in a few cases, it is largely a matter of cost which one is to be pre-

\*A paper read at the American Iron and Steel Institute meeting, May 28, 1920, New York City.

ferred, bearing in mind, however, that even in these classes, as far as quality is concerned, the acid product is superior to the basic, and therefore should command a higher price.

#### ACID VS. BASIC OPEN-HEARTH STEEL

The superiority of acid over basic open-hearth steel, especially for any forgings depending on transverse test-bars for their acceptance, has been repeatedly proved, not only by our own experience, but by that of many others in this country as well as in England and France. Every attempt, for instance, to make heavy ordnance of basic open-hearth steel has from all accounts resulted in nothing but failure.

The reason for this is that the quality of the steel is measured by its freedom from oxides, and that acid open-hearth steel is more free from these oxides than basic steel, because acid open-hearth slag is more effective than basic slag by its reactions with the steel to de-oxidize it.

Of course, there is no open-hearth steel, acid or basic, absolutely free from oxides, nor is there any other steel, no matter by what process made, which under the microscope does not show oxide spots.

Therefore, oxidation is only a matter of degree, and the various processes overlap, so that a badly-melted steel, by whatever process produced, may be worse than a well-melted steel produced by any of the other processes. The claim that acid open-hearth steel is better than basic holds good only in so far as full advantage has been taken of the fact just mentioned in regard to acid slag, as compared with basic.

#### INGOT DEFECTS CAUSED BY OXIDES

The effect on the ingot metal by this difference in the degree of oxidation is shown by the following facts:

1. The amount of deoxidizing finals just sufficient to produce an acid ingot free from blow-holes is not sufficient to make a basic ingot of similar composition solid, but will leave it decidedly blowy. For instance, tire-ingots, which are sliced in lathes into several blocks, and where therefore any lack of solidity in the ingot would be discovered, as the blocks are always carefully inspected just for such a defect, have proved beyond doubt that basic are much more liable to be blowy than acid tire-ingots, and that it is absolutely necessary to add more deoxidizing finals to basic than to acid heats, in order to make basic ingots as free from blow-holes as the acid ones. This proves that basic steel is more oxidized than acid steel. Consequently the greater amount of finals required for deoxidizing the basic steel, reacting with the greater amount of oxides in the steel, will produce a greater amount of the non-metallic impurities resulting from this reaction, chiefly silicates of manganese.

2. The ingot crystals of basic steel as shown by tire-ingots, as well as by numerous experiments with other grades of steel, are very much larger than those of acid steel, poured under the same conditions. For this reason and also because basic is more oxidized than acid steel, the finely divided oxides, still retained by the crystallizing steel and to a greater or less degree expelled by the growing crystals into the intercrystalline space, will thus form in the basic ingot a honeycomb of non-metallic impurities much more serious than in the acid ingot. The ferrite envelope surrounding the ingot grain, which marks the intercrystalline space as the ingot is cooled down, will also be far more distinct

in size and outline in the basic ingot and harder to break up by subsequent forging and heat treatment, but even if this be eventually done, the non-metallic impurities will still remain and seriously affect the quality of the steel.

3. To bring out additional evidence as to the effect of ingot impurities on the internal structure of the ingot, a longitudinal cross-section may now be finish-machined and etched. As a result, there will appear certain dark lines symmetrically disposed on either side of the center line, and running in an oblique direction inward and upward. These lines are the paths taken by metallic segregations high in phosphorus and sulphur, mixed with silicates and sulphides of manganese, resulting from the reactions in the steel after it has been poured into the mold. These impurities remain fluid during the time of crystallization, part of them becoming entangled among the ingrowing crystals, while the rest are driven inward by the solidifying shell, and upward on account of being lighter than the surrounding mother metal, and as they progress toward the center and top of the ingot they coalesce into larger and larger globules and increase more and more in number. They may later be identified in the forging made from the ingot, the metallic segregations high in phosphorus and sulphur as "ghostlines," especially in the bore of hollow forgings, and the silicates of manganese as "slag pockets" or "sand splits" in the machined forging, and also as streaks of "slag" across transverse test bars.

#### COMPOSITION OF GHOSTLINES

The composition of the "ghostlines" was determined at Midvale some years ago by slicing a transverse section off the end of a large hollow forging, made from an ingot which had been cast in a sand-lined mold and which therefore had a great many well-defined "ghostlines" in the bore. On etching this section the "ghostlines" were plainly seen as bright spots, increasing in number from the outside to the bore. These spots were drilled with a  $\frac{3}{16}$ -in. drill, and the drillings, as well as the surrounding metal, analyzed with the following result:

	Per Cent C	Per Cent Mn	Per Cent P	Per Cent S	Per Cent Si
Ghostlines.....	0.497	1.026	0.082	0.116	0.268
Surrounding metal....	0.498	0.894	0.030	0.047	0.316

In regard to the silicate of manganese, opportunity was offered for its analysis by finding a large quantity that had escaped to the bottom of the shrinkage cavity in a 63-in. octagon ingot of basic steel which had had the usual finals for this kind of steel of ferromanganese, ferrosilicon and aluminum. The lower part of this silicate was a yellow-blue, solid enamel, while the upper part was very light and porous, and violet-blue and black in color. The compositions were:

	Per Cent SiO <sub>2</sub>	Per Cent MnO	Per Cent Al <sub>2</sub> O <sub>3</sub>	Per Cent FeO, etc.
Lower part.....	51.60	40.60	7.88	trace
Upper part.....	50.34	29.94	18.90	trace

The defects in the steel resulting from these lines of ingot impurities will be necessarily more serious in basic steel than in acid, specially in regard to the oxides.

The much less serious effect of the segregations high in phosphorus and sulphur, which are the cause of ghostlines, may be modified in basic steel because of the fact that this, as a rule, is lower in phosphorus and sulphur than acid.

Other points considered here are:



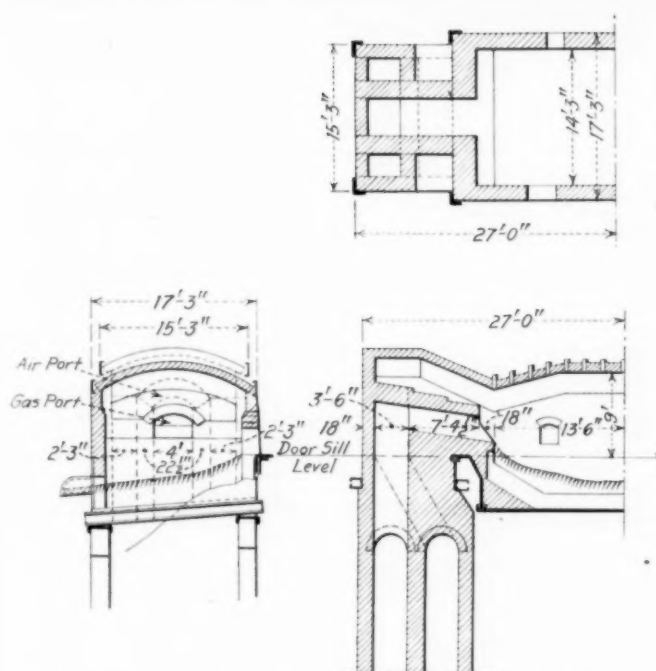


FIG. 1. 50-TON OPEN-HEARTH FURNACE, PRODUCER GAS AS FUEL

The proper design of the furnace for high-grade acid open-hearth steel.

A comparison between producer gas and fuel oil for melting.

An analytical description of the acid open-hearth process as carried out by Midvale.

#### PROPER FURNACE FOR HIGH-GRADE ACID OPEN-HEARTH STEEL

Two designs of open-hearth furnaces are shown, one as adapted for producer gas (Fig. 1) and the other for fuel oil (Fig. 2). The nominal capacity of both is fifty tons, although charges up to 140,000 lb. may be melted. There is nothing peculiar in the designs, as far as valves, flues, regenerative chambers or stacks are concerned, and these parts are therefore not shown. The only unusual feature is the great height of the furnace roof over the doorsill level. This has been a gradual development, and has been found advantageous on account of the high and long sustained temperature necessary to carry out the chemical reactions during the deoxidizing period of the process. The high roof provides a large combustion chamber, which permits a full and free development of the flame, and at the same time avoids damage by the intense heat to the roof and walls of the hearth. Even so, it is advisable with a new furnace to keep it working a few weeks on the less exacting grades of steel, such as tires and bar steel, in order to harden it, before turning it over on the higher grades, as not even the best quality of silica brick will stand at the beginning the high temperature required for these. Toward the end of its life the furnace as a general rule has again to be put back on lower grades of steel, as on account of impaired condition of checkers and draught it is no longer sharp enough for making high-grade steel.

No water-cooled devices of any kind are used in the walls, roof or ports of the furnace, as it has been found as a result of many trials that even when used to a very limited extent their cooling effect interferes with the sharp working of the furnace. The only water-cooled parts used are the charging doors, as they are

far enough removed from the interior not to have a noticeable effect on the heat.

It may be of interest to give here a comparison between the life of acid and basic open-hearth furnaces, when melting with producer gas as well as with fuel oil, as measured by the average number of months from the time of charging the first heat after a general repair, until the time of tapping the last heat before the next general repair. The average number of months is given rather than the average number of heats on account of the great variety of heats made, some requiring twice as long a time as others, and the comparison is based on our records for the last five years.

#### PRODUCER GAS AND OIL AS FUEL

Just as good steel can be made with producer gas as with oil as fuel, and vice versa. Oil is more oxidizing than gas and therefore requires a greater proportion of pig iron in the first charge and a higher temperature after the heat is melted to settle up the metal. On the other hand, oil cuts down the repair cost, re-

#### AVERAGE LIFE OF OPEN HEARTH FURNACES

	Months
Basic furnaces on producer gas.....	9.1
Basic furnaces on fuel oil.....	10.7
Acid furnaces on producer gas.....	11.2
Acid furnaces on fuel oil.....	12.6

quires fewer men per furnace, increases the production, permits better control of temperature, and extends that part of the life of the furnace which is available for making high-grade steel almost to the very end, as the direction of its flame is controlled from the outside and it is less affected by the condition of checkers and draught for generating a high temperature.

Taken all in all, oil is, therefore, much to be preferred as long as its price is not prohibitive.

#### ANALYTICAL DESCRIPTION OF A HEAT FOR ACID OPEN-HEARTH STEEL

The heat considered here, which is marked MK-13-126, was made for steam turbine bucket wheels, which

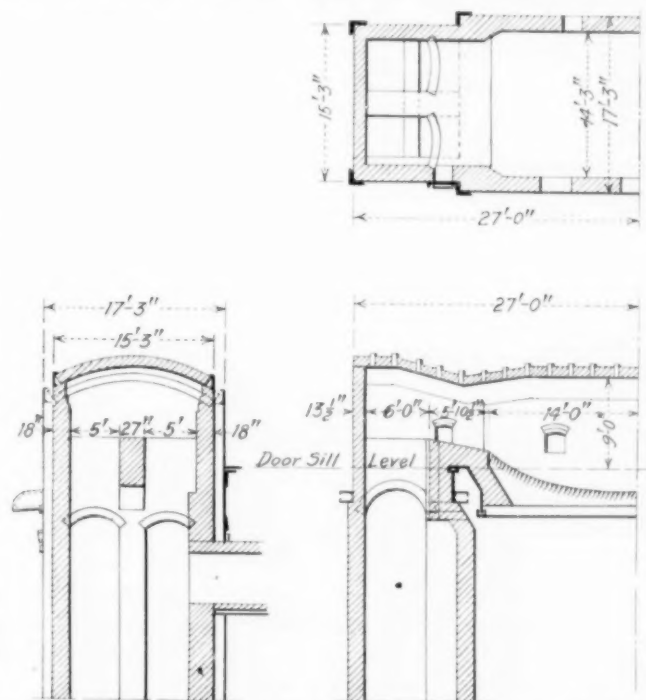


FIG. 2. 50-TON OPEN-HEARTH FURNACE, OIL AS FUEL

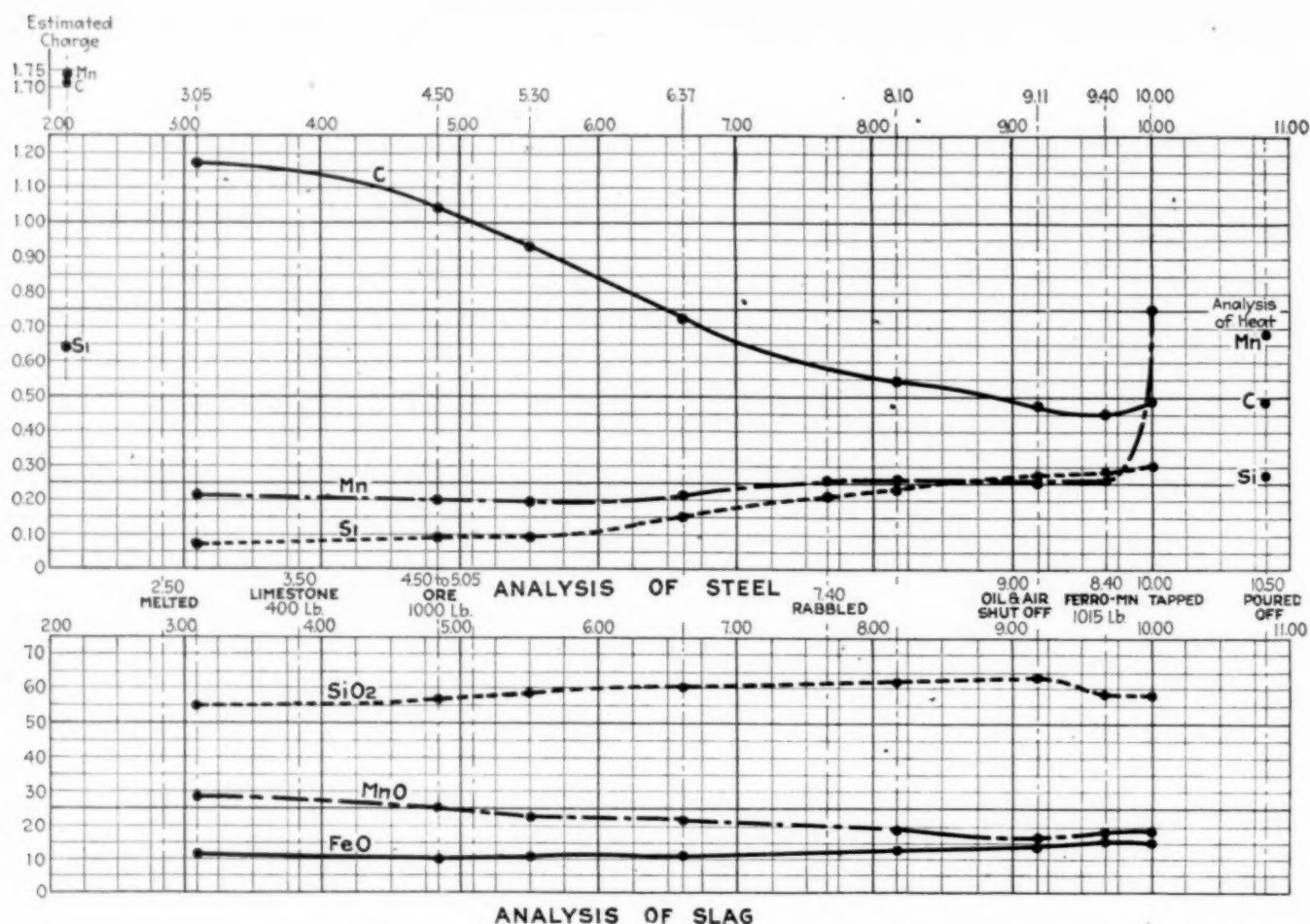


FIG. 3. GRAPHICAL ANALYSIS OF AN ACID OPEN-HEARTH HEAT NO. MK-13-126

require tangential strength, and therefore their acceptance depends on physical properties as shown by tangential test bars. Hence, high-grade acid open-hearth steel is used for their manufacture.

It is a simple heat of plain carbon steel and its treatment is typical of the class of steel to which it belongs. Though not especially selected for this analysis, it may be considered a good, clean heat, without unnecessary complications, and is therefore suitable to illustrate the principles followed in the treatment of the highest grade of steel.

The initial charge of 141,000 lb. melted in a 50-ton acid furnace of the design shown consisted of 35 per cent of pig iron and 65 per cent of scrap. The estimated carbon, manganese and silicon in the charge were C 1.72 per cent, Mn 1.74 per cent, Si 0.64 per cent. Time consumed for heat in furnace follows:

	Hr.	Min.
Time of charging (in two periods).....	1	45
Time of melting.....	5	50
Time in furnace after melting.....	7	10
Total time in furnace.....	14	45

The history of the heat, after the initial charge was melted, may be thus summarized:

hr. 0 min. after melted,	addition of 400 lb. limestone.
hr. 0 min. after melted,	addition of 1,000 lb. iron ore.
hr. 50 min. after melted,	bath thoroughly rabbled.
hr. 10 min. after melted,	oil and air shut off.
hr. 50 min. after melted,	addition of 1,015 lb. ferromanganese.
hr. 10 min. after melted,	heat tapped.
hr. 0 min. after melted,	heat poured off.

The analysis of the go-ahead test, taken 1 hr. 10 min. before tapping, and the C, Mn and Si obtained from 1,015 lb. of ferromanganese added 20 min. before tapping are shown in the following table:

	C	Mn	Si
Analysis of go-ahead test.....	0.49	0.27	0.24 *
Addition of ferromanganese.....	0.05	0.57	0.01
Total.....	0.54	0.84	0.25

\* Judged by fracture.

The table below shows the chemical composition of the heat as aimed at, and as obtained:

Composition	C	Mn	P	S	Si
Aimed at.....	0.50	0.65	0.050	0.050	0.25
Obtained.....	0.49	0.68	0.036	0.038	0.24

On account of the high percentage of Mn in the initial charge the slag remained greenish yellow in color from the time the heat was melted until it was tapped, with only slight variations in shade.

The steel was poured into 23-in. octagon molds, 9 ingots of 10,500 lb., and 3 ingots of 11,400 lb. weight. The ingots, after cooling, were sent to the machine shop to be sliced into blocks, and these blocks were then forged under a steam hammer into bucket wheels for steam turbines.

To facilitate the analytical description of this heat, a graphical analysis chart has been plotted and drawn, showing its chemistry from the time it was melted at 2:50 a.m. until it was tapped at 10 a.m. (Fig. 3).

Eight breaking tests were taken at various times and poured into a standard test mold, about 2 in. deep x 2 in. wide x 6 in. long. These tests were broken and each fracture photographed. At the same time other tests were taken, both of steel and slag, for chemical analysis.

The steel tests were analyzed for C, Mn and Si, and by plotting these determinations on the "Analysis of Steel" chart, curves were obtained showing the changes in these elements.



The slag tests were analyzed for  $\text{SiO}_2$ ,  $\text{MnO}$ ,  $\text{FeO}$ ,  $\text{Fe}_2\text{O}_3$ ,  $\text{CaO}$ ,  $\text{MgO}$ ,  $\text{Cr}_2\text{O}_3$ , and  $\text{Al}_2\text{O}_3$ , but to avoid confusion only the three most important of these oxides,  $\text{SiO}_2$ ,  $\text{MnO}$  and  $\text{FeO}$ , were plotted on the "Analysis of Slag" chart, to show the changes taking place in the composition of the slag during the progress of the heat. The full analysis of each slag test is:

SLAGS FROM M.K.-13-126

	$\text{SiO}_2$	$\text{MnO}$	$\text{FeO}$	$\text{Fe}_2\text{O}_3^*$	$\text{CaO}$	$\text{Cr}_2\text{O}_3$	$\text{Al}_2\text{O}_3$	$\text{MgO}$	$\frac{\text{MnO}}{\text{FeO} + \text{Fe}_2\text{O}_3}$	Total
1	55.0	28.0	11.1	1.4	2.6	0.3	1.4	0.6	43.1	100.4
2	57.0	25.0	10.3	0.6	3.9	0.3	1.4	0.6	39.8	99.1
3	58.7	22.7	11.0	0.7	3.9	0.2	1.9	0.8	37.9	99.9
4	60.7	21.3	10.5	0.9	3.3	0.2	1.5	0.8	36.0	99.3
5	62.2	18.7	12.7	1.0	2.5	0.2	1.5	0.7	34.9	99.5
6	63.0	16.5	13.9	0.9	2.5	0.2	1.5	0.5	33.8	99.0
7	58.5	18.0	15.5	2.1	2.4	0.2	1.6	0.6	38.0	98.9
8	58.4	18.8	15.0	0.4	2.4	0.2	1.5	0.5	36.6	97.2

## TEST No. 1

Commencing with test No. 1, taken at 3:05 a.m., or 15 min. after the heat was melted, its analysis shows the oxidation of C, Mn and Si during the time of melting by comparing it with the estimated percentage of these three elements in the initial charge. C has dropped from 1.72 to 1.17 per cent, Mn from 1.74 to 0.21 per cent, and Si from 0.64 to 0.07 per cent. A considerable percentage of Mn in the first charge is highly desirable, because by its oxidation during the melting it gives a clean slag, greenish yellow in color, almost from the start, and if the pig iron doesn't contain enough Mn, this deficit is made up for high-grade steel by the addition of ferromanganese to the initial charge. A high percentage of both Mn and Si is also desirable in the initial charge on account of their oxidation being an exothermic reaction, facilitating the melting and giving a bath hotter and less sluggish with iron oxide by the time the charge is melted. Both these elements oxidizing at a lower temperature than carbon, their oxidation, as far as it goes, is practically complete by the time the charge is melted, while the carbon is still comparatively high.

Care is now necessary in the addition of iron ore for de-carburizing the metal, as this is an endothermic reaction, absorbing heat and requiring a high degree of temperature for a vigorous reaction between the oxygen of the ore and the carbon of the steel. If the addition of ore is made too soon, or in too large a quantity, its chilling effect may so retard this reaction that when finally the high temperature required is reached and the bath goes into a boil, this will carry the decarburization so far that by the time the bath is well settled up the carbon in the steel is well below the carbon aimed at. This would necessitate additions of spiegel and pig iron in order to recarburize the heat. Such a condition is almost fatal to the production of high-grade steel, because the lower the carbon in the go-ahead test as compared with the carbon aimed at and therefore the greater the addition of recarburizing finals, the greater will be the amount of silicate of manganese produced. This may quite likely lead later on to the condemnation of the forgings made from such a heat on account of "sand-splits" or "slag-enclosures," or on account of transverse test bars failing in extension and contraction, due to streaks of "greenish slag" or "woody structure" caused by these streaks, or, in the case of projectiles, on account of cracks starting from small slag enclosures during the hardening process, or on account of the projectiles selected for the firing test, breaking up in striking the

face-hardened armor on account of the weakening effect of these concealed impurities.

Hence the reason for the note on the melting order: "Add no ore until 2 hr. after melted." Except steadily increasing the temperature of the heat during these 2 hr., the only thing done was the addition of 400 lb. of limestone 1 hr. after the charge was melted. By displacing a certain amount of iron oxide in the slag and making it more fluid, the limestone seems to put it in a better condition for subsequent reactions, at least where there is a low manganese content in the initial charge.

This, however, is, in my opinion, the only time when addition of lime is of any value. If done later during the de-oxidizing period of the heat, it will simply undo all the good that has been done, because replacing the  $\text{FeO}$  in the slag then will drive this into the steel to oxidize the silicon and manganese and make the bath again raw and unsettled.

## TESTS NOS. 2, 3, 4 AND 5

At the end of two hours, test No. 2 was taken. This shows the oxidation of the carbon, slow at first on account of lack in temperature, now well under way. There having been as yet no addition of iron ore, this oxidation is caused by the rust in the initial charge, by oxidation of the charge in melting and by the oxidizing effect of the flame itself.

The higher temperature of the slag is also shown by its slightly higher percentage of  $\text{SiO}_2$ .

Test No. 3, taken 40 min. after No. 2, shows the oxidation still going at the same rate, due to the addition of 1,000 lb. of iron ore during the interval. The only effect of this addition on the slag is a slight increase in  $\text{FeO}$ , the  $\text{SiO}_2$  continuing to rise and the  $\text{MnO}$  slowly decreasing by dilution with the  $\text{SiO}_2$ , taken up by the slag from the bottom along the slag line.

Test No. 4, taken 1 hr. and 7 min. after No. 3, shows the oxidizing period at an end. The  $\text{SiO}_2$  in the slag has now gone up from 55.0 per cent, 15 min. after the heat was melted, to 60.7 per cent, while the two chief bases,  $\text{MnO}$  and  $\text{FeO}$ , have dropped from a total of 39.1 per cent to 31.8 per cent, in spite of the lower carbon in the steel. But most marked and showing that the de-oxidizing period has set in, is the increased percentage of Si in the steel, caused by the reaction between the carbon of the steel and the  $\text{SiO}_2$  of the slag, according to the formula:



Whereas during the melting of the charge on account of the low temperature then prevailing, the oxidation of Si was going on at a much greater rate than the oxidation of the carbon, with the steadily increasing temperature this oxidation of Si was first checked, then held, until finally a complete reversal has taken place, the very high temperature now reached having so increased the affinity of carbon for oxygen that it is able to reduce Si out of  $\text{SiO}_2$ , leaving the Si free, in its nascent and therefore most efficient state, to de-oxidize the steel, as shown by the increasing solidity and freedom from blow-holes of subsequent tests. This reaction is the essential point that accounts for the difference between acid and basic steel and that which makes acid steel superior to basic.

What has just been said in regard to the effect of the increased temperature on the relative affinity of C and Si for oxygen is also shown to have taken place in the relative affinity of C and Mn for oxygen, the C now

\*Any metallic Fe present was determined as  $\text{FeO}$ . This would result in a high figure for  $\text{FeO}$  and a low figure for  $\text{Fe}_2\text{O}_3$ .

reducing Mn out of the MnO of the slag, the nascent Mn also assisting in the de-oxidation of the steel. This manganese reaction, however, which also may take place in a basic open-hearth heat, is much less effective than Si in de-oxidizing the steel, because the de-oxidizing effect of Mn is much less than that of Si, the latter, according to Brinell, being 5.2 times more effective than the former.

Test No. 5 shows the characteristic "worm-holes" well developed from the increased absorption of Si, which has gone up to 0.23 per cent. The only thing done with the heat between tests Nos. 4 and 5 was to give the bath a thorough rabbling with steel bars to facilitate the liberation of gas. Nothing else is now being done except to keep on pushing the temperature higher and higher to promote the reaction between C and SiO<sub>2</sub>.

The reason why the carbon curve is still on a downward slope, in spite of the now well-settled-up condition of the bath, is no longer the reaction between the iron oxide of the slag and the carbon of the steel, which occurred during the oxidizing period of the heat, but the reactions of the de-oxidizing period between the carbon in the steel and the SiO<sub>2</sub> and the MnO of the slag, the Si and Mn, as previously explained, being constantly reduced to act as carriers in de-oxidizing the steel, while the CO resulting from this reaction bubbles slowly up through the slag. Assuming that when No. 5 test was taken the percentages of Si and Mn in the steel were the same as when No. 3 test was taken, it may be shown by a simple calculation that the carbon then would have been about 0.67 per cent, instead of having dropped to 0.54 per cent, so that but for this later reaction of the de-oxidizing period the carbon line would have been almost horizontal.

#### TESTS NOS. 6, 7 AND 8

Test No. 6 shows the de-oxidizing process almost complete, the "worm-holes" of the previous test having been nearly obliterated by the steadily increasing percentage of Si. The heat would now have been ready for the final addition of ferromanganese made just before tapping, except for the fact that the carbon, according to the first go-ahead test, was still a little too high or 0.53 per cent. A second go-ahead test had therefore been taken out 10 min. ahead of test No. 6, and on this being reported as being down to 0.49 per cent carbon the ferromanganese was added at 9:40 a.m., and the heat tapped at 10 a.m., or 20 min. later.

Test No. 7, taken just before adding the ferromanganese, is very little different in appearance from test No. 6, while test No. 8, taken after the addition of ferromanganese and just before tapping the heat, is absolutely solid. The Si in this test was 0.30 per cent, while the Si in the heat test, taken while pouring the steel into the molds, was 0.27 per cent, which shows that the Si in the steel while still in the furnace is higher in the stratum close to the slag, from which test No. 8 was taken and where the reduction of Si from the slag is taking place, than the average Si of the whole mass of steel.

Aluminum and titanium are never used for de-oxidizing steel in which transverse strength, as determined by transverse tests, is required, because the oxides of these elements have a very baneful effect on the physical properties of such tests, even when used very sparingly. It is difficult to believe, but it is nevertheless a fact, that this effect of aluminum, added into the ladle at the rate of 1 lb. of aluminum to 10,000 lb. of steel and held 25

min. before pouring, very likely will cause the condemnation, on account of failing test bars, of a gun forging made from this steel.

#### INFLUENCE OF SHUTTING OFF THE FUEL AND AIR 1 HR. BEFORE TAPPING

There is one more point in regard to the chemistry of this heat that requires an explanation. That is the shutting off of the oil and air, which also implies the lowering of the stack-damper, 1 hr. before tapping.

It may be noticed on the "Analysis of Steel" chart that this had no effect on the C, Mn and Si curves. On the "Analysis of Slag" chart, however, the result was a sudden drop in the SiO<sub>2</sub> curve, and a corresponding, but less marked, rise in the MnO and FeO curves. This, of course, does not mean a loss of SiO<sub>2</sub>, as far as the actual weight of this oxide in the slag is concerned. What has occurred is an absorption by the slag of an additional amount of the two basic oxides, MnO and FeO, from some source, thus making the slag less acid than it was before.

The thermal effect was a very decided cooling of the slag, while, on account of slag being a poor heat-conductor, the temperature of the steel underneath the slag was by comparison only slightly lowered.

The reasoning which first led me to try this treatment with the point in view of still further de-oxidizing the steel was this:

As the temperature of an acid heat rises, by degrees de-oxidizing the bath through the reactions between the slag and the steel made possible by this rise in temperature, a point is finally reached where this reaction has to be stopped, in order not to get the steel too high in Si. If at that point the furnace were suddenly cooled by shutting off the flame, the effect would be a sudden cooling of the slag, while the temperature of steel, protected from radiation of heat by the blanket of slag, would be only slightly affected. This thermal change would have the effect on the slag of considerably increasing its affinity for basic oxides. The only supply of these oxides then available would be the traces still retained by the steel, which would therefore to a greater or less degree be absorbed by the slag. On account of the weight of slag in a heat being only about 7 per cent, while the steel makes up about 93 per cent, or thirteen times the weight of slag, a trace of oxides in the steel if absorbed by the slag would be quite a noticeable amount.

This, I believe, is the explanation of the change in the composition of the slag, resulting from shutting off oil and air for 1 hr. before tapping. This treatment was first tried more than seventeen years ago, since which time it has been in continuous use, especially in the case of carbon and nickel steel for large ingots.

The cooling effect on the steel, although slight compared with that on the slag, is also advantageous in order to lower the temperature for pouring large ingots, as otherwise the high temperature of the steel would make the ingots pull badly in forging. For this reason the steel is still further cooled by holding it from 20 to 30 min. in the ladle before starting to pour.

This ends the difference in the treatment of acid from that of basic open-hearth steel. I only want to add that though this treatment is simple enough, it requires great skill and good judgment on the part of the men in the shop, and that uniformly good results can be obtained only by careful and intelligent men after many years of training.



## Similarity of the Magnetic Change in Cementite and Ferrite

By MISS H. G. MOVIUS and HOWARD SCOTT\*

THE purpose of this paper is to present evidence that the transformation of cementite from the paramagnetic to the non-magnetic state is accompanied by a detectible thermal effect similar to that accompanying the corresponding transition in pure iron. This behavior of cementite as exhibited in steels and cast iron, in which the carbon is in the form of free cementite in its ferrite matrix, was probably discovered by Wologdine<sup>1</sup> and has been studied by means of magnetic methods by Honda<sup>2</sup> and by Smith<sup>3</sup>.

Separating the cementite from its matrix of ferrite, its transformation has been studied by Honda and Murakami<sup>4</sup> and by Ishiwaru<sup>5</sup>. Honda and Murakami, by means of this method, determined the critical temperature of this transformation of cementite, which they call  $A_0$ , to be 215 deg. C., the critical temperature being defined as the temperature at which the transformation ends on heating and begins on cooling.

Chevenard<sup>6</sup> has detected this transformation in steel by means of expansivity measurements and Iitaka<sup>7</sup> by means of resistance measurements.

By obtaining differential cooling curves on white pig iron, Honda and Takagi<sup>8</sup> have shown an obtuse inflection

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<sup>1</sup>Wologdine: *Compt. Rend.*, vol. 148, p. 776 (1909).  
<sup>2</sup>Honda, *Sci. Rep.*, Tohoku Imp. Univ., vol. 2, p. 203 (1913).  
<sup>3</sup>Honda & Takagi, *Ibid.*, vol. 4, p. 161 (1915). Honda, *Ibid.*, vol. 6, p. 149 (1917).  
<sup>4</sup>Smith: *Proc. Phys. Soc. of London*, vol. 25, p. 77 (1912).  
<sup>5</sup>Honda & Murakami, *Sci. Rep.*, Tohoku Imp. Univ., vol. 6, p. 23 (1917).  
<sup>6</sup>Ishiwaru, *Ibid.*, vol. 6, p. 285 (1918).  
<sup>7</sup>Chevenard, *Rev. de Met.*, vol. 16, p. 17 (1919).  
<sup>8</sup>Iitaka, *Sci. Rep.*, Tohoku Imp. Univ., vol. 7, p. 167 (1918).  
<sup>9</sup>Honda and Takagi, *Sci. Rep.*, Tohoku Imp. Univ., vol. 4, p. 161 (1915).

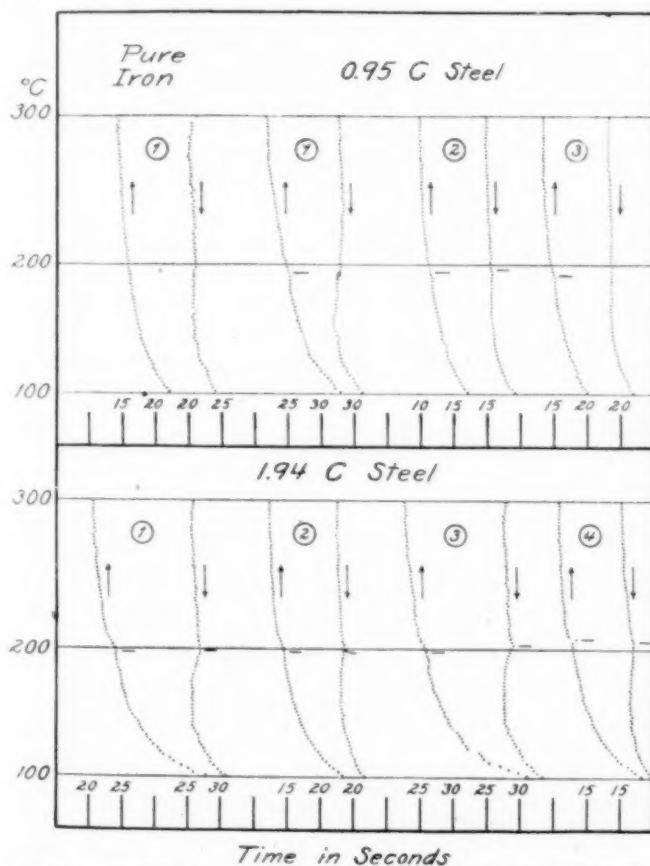


FIG. 1. THERMAL CURVES IN REGION OF CEMENTITE TRANSFORMATION

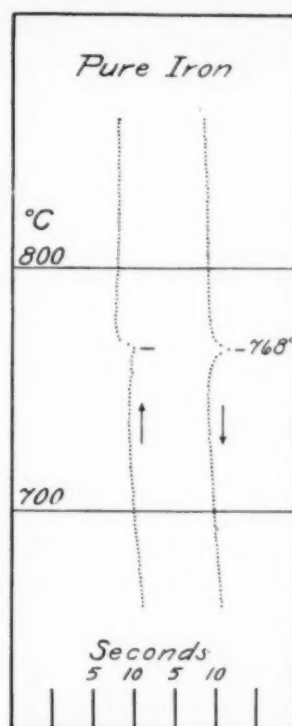


FIG. 2. THERMAL CURVES OF PURE IRON IN REGION OF  $A_2$  TRANSFORMATION

in the neighborhood of 200 deg. C.

The changes in the physical properties of cementite measured by the above-mentioned authors show a strong resemblance between the magnetic transformation of cementite and that of ferrite, so it is not surprising that this resemblance persists in the behavior of the material upon heating as detected by thermal analysis and reported here. For the purpose of the comparison, thermal curves were taken by the inverse rate method in the manner recently described<sup>9</sup>. The materials studied were a pure iron, a eutectoid carbon steel and a 1.94 carbon iron-carbon alloy of the composition given in Table I.

The pure iron and iron-carbon alloy were prepared as described in Bureau of Standards Scientific Paper 266, and hence any impurities

other than those given in the table are present only in minute quantities; the total impurities are probably less than 0.04 per cent.

The thermal curves, in which the behavior of the material of these three compositions when heated over the temperature range 100 to 300 deg. C. is recorded, are shown in Fig. 1, while Fig. 2 shows those of the pure iron when heated over the  $A_2$  range. The steels

TABLE I. CHEMICAL COMPOSITION OF STEELS

	C	Mn	Si	S	P
Pure iron	0.03	0.003	0.005	0.005	
Eutectoid steel	0.95	0.22	0.24	0.01	0.02
Pure iron-carbon alloy	1.94		0.01	0.005	

were in the pearlite state and no graphite was present in the 1.94 C steel. It may be noted from the curves that the intensity of the  $A_0$  transformation in the 1.94 carbon steel is small in comparison with  $A_2$  of the pure iron, but that it has the same distinguishing characteristics, that is, a gradual approach to the maximum, a lack of definite hysteresis between the maximum on heating and on cooling, and a difference in form between the  $A_c$  and  $A_r$  inflections which the curve for pure iron shows very clearly. For the sensitivity of the apparatus employed, the transformation,  $A_0$ , is only barely perceptible in the 0.95 carbon steel and cannot be detected in instances where vibrations of the building and other extraneous influences mask the heat effect. The inflection, of course, is not visible in the pure iron curve, which has been plotted mainly to show the furnace characteristics over the temperature range investigated. The intensity of the curve inflection of  $A_0$  can be magnified by choice of a more sensitive thermocouple if so desired.

The temperature values of the maximum thermal inflection, as noted on the curves, are given in Table II.

<sup>9</sup>Scott and Freeman, Bureau of Standards Scientific Paper 348. Also *Bulletin* 152, A.I.M.E., p. 1429.

From this table it appears that the maximum of the transformation occurs at a slightly higher temperature in the higher carbon and steel in which the manganese and silicon are practically nil and that in this case its temperature is in the neighborhood of 200 deg. C. Rate of temperature change has no appreciable effect over the range of rates used on its position, as is also the case with  $A_s$  of pure iron<sup>10</sup>.

The difference between the temperature given by Honda (215 deg. C.) and the one given here (200 deg. C.) for  $A_o$  does not imply an experimental error in

TABLE II. TEMPERATURES OF CRITICAL POINT OF CEMENTITE

Per Cent C	Curve No.	Rate of Heating Deg. C. per Sec.	$A_o$ Deg. C.	Rate of Cooling Deg. C. per Sec.	$A_o$ Deg. C.
0.95	1	0.09	194	0.08	...
0.95	2	0.16	191	0.12	...
0.95	3	0.21	192	0.14	194
1.94	1	0.10	198	0.09	199
1.94	2	0.18	199	0.12	200
1.94	3	0.09	199	0.08	202
1.94	4	0.19	207	0.14	205

either case, for the values are taken as previously defined from non-coincident points on curves which represent a transformation of the continuous type.

Thermal curves taken on a eutectoid and a 1.94 carbon steel show the magnetic transformation of cementite in both, but more marked in the latter. It has the thermal characteristics peculiar to the  $A_s$  transformation of pure iron and occurs as a maximum in the pure iron-carbon alloy at approximately 200 deg. C.

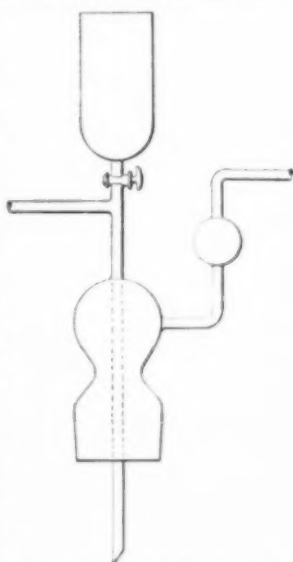
The thermal change at  $A_o$  for the carbon tool steel is so small as to be hardly discernible and consequently cannot be confused with the thermal phenomenon observed on heating hardened steels through the same temperature range.

Washington, D. C.

### Special Gas Wash-Bottle for Use in the Referee's Test for Sulphur

BY A. E. MAZE\*

In the referee's test for total sulphur in gases the gas is burned in a suitable burner, where the sulphur is converted to sulphur dioxide. The products of combustion are carried into a series of wash bottles containing an alkaline solution of bromine, where sulphur dioxide is absorbed and oxidized to sulphuric acid. If sufficient bromine is added at the beginning to suffice for the entire test a very large excess must be used. To keep the bromine consumption at a minimum only a slight excess is added at the beginning and the bromine is replenished from time to time. To maintain the flame in the burner considerable suction must be applied to the wash bottles. In adding bromine the bottle nearest the burner is opened and in this way the draft is interrupted and frequently the flame is extinguished. At times this may not be noted for some time and the test rendered useless.



<sup>10</sup>Burgess and Crowe, Bureau of Standards Scientific Paper 213, also A.I.M.E., vol. 47, p. 665 (1913).

\*Chemist, Denver Gas & Electric Light Co.

To eliminate this difficulty a wash-bottle having a funnel and cock in the inlet is placed directly after the burner. The figure represents the top of such a wash-bottle. Through this funnel the bromine may be added in required quantities, without interrupting the draft or endangering the flame.

### Hydro-electric Power Development in France

The hydro-electric resources of France are estimated at from 8,000,000 to 10,000,000 hp., about 4,000,000 of which is in the regions of the Alps; in Massif Central, Vosges, and Jura, 1,500,000; in Pyrenees, 1,700,000; and in other regions, 800,000. Between 1869 and 1899, 150,000 hp. was developed. In September, 1902, statistics presented at a water-power congress held at Grenoble showed that 200,000 hp. had been developed. After 1902 development progressed as follows: By 1905 there was a total of 450,000 hp.; by 1910, 650,000; by 1913, 750,000; by 1914, 800,000.

Between 1916 and 1918 it was estimated that 450,000 hp. was developed, bringing the total development up to the time of the armistice to 1,250,000 hp. Projects started in 1919, totaling 175,000 hp., and projects planned for construction in 1920-1921, developing 225,000 hp., will bring the total development in 1921 to 1,650,000 hp., or about 20 per cent of the total available.

The power development between the end of 1915 and 1921, about 850,000 hp., is divided among the several regions as follows: Alps, 428,000 hp., Pyrenees, 185,000; central France, 200,000; Jura and Vosges, 35,000; West, 2,000.

Thus it will be seen that nearly 50 per cent of the power development of France will have been accomplished in six years. The purposes for which power was developed during this period were: Industrial uses, 308,000 hp.; electrochemistry, 216,000; electrometallurgy, 326,000.

When completed these plants will represent a capital investment of \$127,766,000. Prior to 1915, \$154,400,000 was invested in power plants in France, making a total investment to date of \$282,166,000.

### Condition of the Scottish Shale Oil Industry

The reports of the Scottish shale oil concerns, issued in the early months of 1919, showed very satisfactory returns, in one instance the dividend being as high as 40 per cent, including income tax, but later developments, due to labor difficulties and a general increase in operating expenses, placed the industry in a much less favorable position. At meetings of stockholders and directors held later in the year, gloomy forecasts as to the future of the industry were made, and a severe drop took place in all the shares. Negotiations were entered into by the Scotch companies with the Anglo-Persian Oil Co., with the result that a new company was formed, called the Scottish Oils, Ltd., which took over the ordinary shares of the Scotch companies. It is stated that the new development is likely to lead to a largely increased quantity of crude oil being dealt with in the Scottish refineries, for, while the refining of shale oil will continue, it is expected that imported crude oil will be used to supplement the shale oil supplies, thus keeping the refineries fully employed. It is probable that this arrangement will improve the situation of the shale oil companies, although the actual production of shale oil may decrease.



## Nitrogen Fixation by the Haber Method

Theoretical Consideration of the Process—Preparation of Gases for Catalysis—Design of Apparatus—Existing Plants—United States Nitrate Plant No. 1—Cost and Difficulties in Operation—Future Development by the Government—Conclusion as Compared With Cyanamide Process

By CHESTER H. JONES

IN REFERRING to the four most important processes discussed in connection with nitrogen fixation—namely, the arc process, the Haber process, the cyanamide process and byproduct ammonia output—it is essential that the characteristic difference of each be noted as distinguishing it from others. Confusion may be avoided by remembering that the arc process delivers nitric acid or some form of nitrate as the primary stable compound, while the three others produce ammonia in the form of a gas.

The Haber process is often called the synthetic process, but is no more truly synthetic than the arc or the cyanamide method. The arc and Haber operations involve the handling of gases and liquids, while the cyanamide deals principally with solids up to the final stage. In the manufacture of byproduct coke and in gas works as well, ammonia is given off as an incidental gas. It is usually absorbed in sulphuric acid to form ammonium sulphate, and this can also be accomplished with the ammonia from either the cyanamide or the Haber process.

### HABER METHOD

The procedure consists in forming synthetic ammonia by passing a mixture of hydrogen and nitrogen, previously purified, over a suitable catalyst under a pressure of 3,000 lb. per sq.in. (20.7 kg. per sq.cm.) at a temperature of 550 deg. C. The composition of the catalyst compound which is commercially successful is a secret known to Germany alone, although it is thought to be a modified iron composition in spongy form.

About 70,000 cu.ft. of hydrogen and 23,500 cu.ft. of nitrogen (1,960 and 458 cu.m. respectively) rated under normal temperature and pressure is required theoretically for every metric ton of ammonia produced. Depending upon the condition of the catalyst and the purity of the gases only a relatively small amount of the total volume passing through the catalyzer bombs or con-

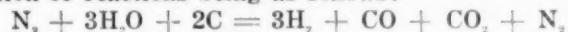
tainers is actually converted into ammonia, and it is therefore necessary to separate the latter from the system by refrigeration, returning the excess uncombined gases for recirculation.

### PRODUCTION OF GASES

While hydrogen may be secured from any one of several sources, such as the electrolytic cell, with its consequent byproduction of oxygen; the steam-iron processes used in connection with the fat hardening industry; or the Linde water-gas method as first attempted and subsequently abandoned, the most promising source of both hydrogen and nitrogen is the water-gas plant well known in the commercial gas industry. In recent developments of the process additional nitrogen is introduced near the end of the operation, as will be later described.

### BLUE WATER-GAS

An ordinary water-gas plant is installed in which steam is blown into a bed of incandescent coal, where it is dissociated into hydrogen and oxygen, the latter immediately reacting with the carbon to produce carbon monoxide. Some carbon dioxide is also formed, the summation of reactions being as follows:



The nitrogen enters in the form of air and passes into the gas holders with the other gases. It is readily noted that the right hand side of this equation contains the necessary hydrogen and nitrogen to produce ammonia and that further it will be required to remove the carbon monoxide and dioxide before the proper combination can be effected.

### PREPARATION FOR CATALYSIS

The blue water-gas is drawn from the gas holders into large compressors, where it is raised to 200 atmospheres pressure and passed into mains leading to the first preheater. It then enters the  $\text{CO}_2$  catalyzers, where all the carbon monoxide is converted to carbon dioxide through combination with the oxygen, which entered with the original air, but is not shown in the equation above. The catalyst employed is probably an activated ferric oxide. Some chromium oxide may be present.

The mixed gases coming from these catalyzers, still under high pressure, are carried on to washing towers, where the carbon dioxide is removed by water. Fifty per cent of the energy required for pumping water into these towers is recovered from the high pressure exhaust water by means of a Pelton wheel. It has recently been proposed that the carbon dioxide in this wash water be employed in making soda ash, or for other manufacturing purposes.

The traces of carbon monoxide still remaining in the hydrogen-nitrogen mixture are then removed in a puri-

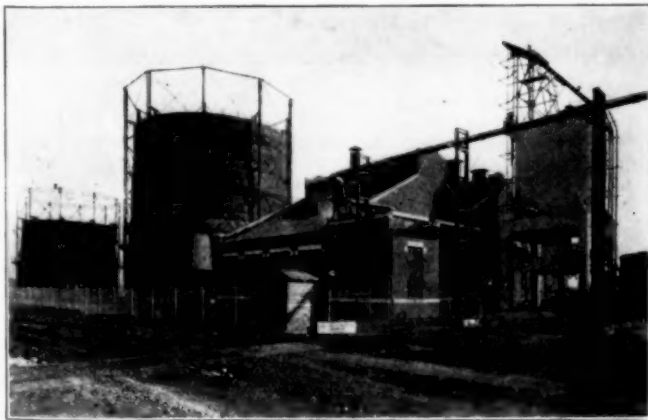


FIG. 1. WATER GAS PLANT FOR PRODUCING THE TWO REQUISITE GASES AT U.S.N.P. NO. 1

fier containing ammoniacal cuprous chloride solution of such strength as not to attack the iron container. There are said to be other purifiers in series with this one for the removal of oxygen and perhaps some other impurities which may be harmful to the ammonia catalyst, but definite information is not available for publication at this time.

The completely purified gases, and they must be very pure indeed, finally enter drying towers for the removal of all the moisture. These towers employ calcium chlo-



FIG. 2. AMMONIA PROCESS BUILDING, WHERE GASES ARE SYNTHESIZED TO AMMONIA. U.S.N.P. NO. 1

ride as a drying agent in at least one plant. Thence they are conducted to a preheater, where the temperature is raised to 550 deg. C., and subsequently into the ammonia catalyzer. The reaction is shown by the equation



The ammonia is separated from the uncombined gases in a standard refrigeration system with liquefying arrangement. The residual nitrogen and hydrogen are returned to the system, as previously mentioned. The liquid ammonia is permitted to evaporate and pass into the mains or standard type of gas holders.

#### MECHANICAL DESIGN OF APPARATUS

Because of the high working pressures all apparatus, including catalyzers, preheaters, washing towers, piping and valves, must be of extremely heavy design. The washing towers, for example, are large steel forgings resembling in appearance the huge naval guns. They are made from chrome-vanadium steel and have walls several inches in thickness.

The bombs containing the ammonia catalyst are built for resistance to pressure, lined with a refractory to resist the high temperature and with additional provision against leakage of hydrogen to the atmosphere with consequent explosion. The latter feature is covered in the most recent design by surrounding the container with an atmosphere of pure nitrogen under pressure slightly in excess of that within, so that in case of any leak the inert gas will flow inward and little harm result. The nitrogen is supplied for this purpose from standard Claude or Linde liquid air plants.

Those who have seen the immense installations at Oppau and Merseburg in Germany speak in most complimentary terms of the marvelous mechanical achievements entering into the makeup of these plants. One observer stated it made him feel proud of the human race to view the work even if it had been carried on by an enemy people.

The General Chemical Co. process, also known as the modified Haber or the De Jahn process, after the in-

ventor, is essentially as described in the foregoing paragraphs except the plant is operated under a pressure of 100 atmospheres and a different catalyst is employed in the ammonia plant. The mechanical features are also of a considerably lighter design. The German plants differ in that nitrogen is secured from liquid air apparatus, only hydrogen being used from the water-gas plant.

#### EXISTING PLANTS

There are only three plants using the Haber method in the world today, with a fourth under construction. Only two of these have ever operated successfully. The first is located at Oppau, Germany, with a rated capacity of 400 tons of ammonia per day; the second at Merseburg, rated at 700 tons per day. U. S. Nitrate Plant No. 1, Sheffield, Ala., is designed to produce fifteen tons per day, but has never passed the experimental stage of operation. The Atmospheric Nitrogen Corporation, capitalized for \$5,000,000, with a directorate made up of General Chemical Co. and Solvay Process Co. officials, is erecting a plant employing the De Jahn process near Syracuse, N. Y. Ten units are being installed. The total capacity of this plant has not been made public, but it will probably not exceed sixty tons of ammonia per day.

Experimental work was carried forward both in this country and abroad during the war, all on a laboratory scale except the Government plant mentioned above. It is evident that the commercial organizations learned enough through the research at this plant to risk considerable capital in the new venture.

#### DEVELOPMENT IN GERMANY

Although many difficulties were encountered in constructing a commercial catalyst unit capable of withstanding the necessary pressure and temperature, the process was eventually brought to a commercial stage

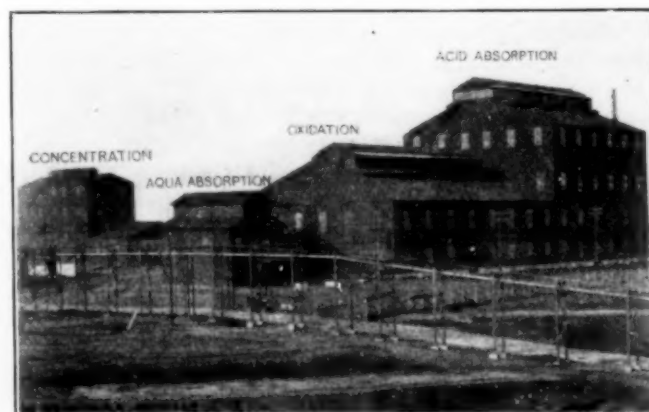


FIG. 3. NITRIC ACID PLANT U.S.N.P. NO. 1. THE AMMONIA MAY BE EITHER ABSORBED IN WATER TO PRODUCE AQUA OR OXIDIZED OVER PLATINUM GAUZZES AND SUBSEQUENTLY ABSORBED IN WATER TO PRODUCE NITRIC ACID

in Germany in 1913. It has been said that the government would never have entered the war without the prospect of explosive output from this process. The production of ammonia from these plants was as follows:

	Tons
1913 .....	7,500
1914 .....	15,000
1915 .....	37,500
1916 .....	75,000
1917 .....	125,000
1918 .....	265,000



In terms of ammonium sulphate these quantities are multiplied by a factor of 5.6, giving a production of 1,960,000 tons ( $\text{NH}_4\text{SO}_4$ ) for 1918.

The Germans have jealously guarded the details of the process and very little real information was brought to this country by our investigators during the war. The samples of catalyst supposedly coming from Germany were never large enough to analyze. Even since the armistice no commercial details have been made available to the Government.

#### OTHER DEVELOPMENTS

The Nitrogen Products Committee of the British Government has issued a final report which is now a matter of public record. This publication, Cmd. 482, contains a wealth of information relating to the process as investigated by the Ministry for Munitions of War. The committee experienced difficulty in estimating the degree of reliability to be accorded to the evidence on costs that had been obtained, but the results provided assistance in the formation of tentative conclusions.

In view of the claims that the process was capable of producing ammonia and ammonium sulphate at a low cost, and that the power requirements per unit of nitrogen were much smaller than any other process of fixation, information was collected from every available source. The economics of the process are principally governed by (a) the cost of the gases, particularly that of hydrogen of the requisite degree of purity, and (b) the capital cost of the catalyst or high-pressure section of the plant with the cost of its maintenance.

Because of the doubtful value of the figures and the difficulty of translating them to apply to manufacturing conditions in the United States they are omitted from this article. Modifications recently made in design of plants also alter the manufacturing costs.

Among other recommendations, however, the committee advised that "The synthetic ammonia process should be established forthwith on a commercial unit scale and extended as rapidly as possible, as a post-war measure, up to a minimum manufacturing scale of 10,000 tons of ammonia (equivalent to 40,000 tons of ammonium sulphate) per annum." The United States will not be up to this figure if the plant at Sheffield is operated under the bill now before Congress.

France and Italy have done practically nothing with the Haber process, relying for production on the cyanamide plants.

#### CONSTRUCTION OF U. S. NITRATE PLANT No. 1

Official report of the Nitrate Supply Committee and some of the circumstances following its presentation are best described in a document submitted to the Graham House committee by Colonel J. W. Joyes in his testimony, Jan. 3, 1920, as follows:

With the object of securing an opinion, based upon a comprehensive view of all the facts collected by the several agencies, the Secretary of War appointed the following Committee on Nitrate Supply:

Brigadier General William Crozier, Chief of Ordnance, United States Army, War Department; Rear Admiral Ralph Earle, Chief of Bureau of Ordnance, United States Army, War Department; Brigadier General William M. Black, Chief of Engineers, United States Army, War Department; F. W. Brown, Bureau of Soils, Department of Agriculture; Dr. Leo H. Baekeland, Yonkers, N. Y.; Gano Dunn, 43 Exchange Pl., New York; Dr. Charles H. Herty, 35 East Forty-first St., New York; Dr. William F. Hillebrand, Bureau of Standards, Department of Commerce; Dr. Arthur A. Noyes, Institute of Technology, Boston, Mass.; Dr.

Charles L. Parsons, Bureau of Mines, Interior Department; Dr. Willis R. Whitney, Schenectady, N. Y.

This committee gave careful consideration to all the information available, and duly weighed the several purposes stated by the language of the act, recommending the following action:

I. That the Government negotiate with the General Chemical Co. for the right to use its synthetic ammonia processes.

II. That contingent upon satisfactory result of such negotiations, there be set aside from the \$20,000,000 appropriated, such sum, estimated as about \$3,000,000, as should be necessary to build a plant to produce by that process about 60,000 lb. of ammonia per 24-hr. day; location, southwest Virginia preferably.

III. That out of the same appropriation \$600,000, or as much more as needed, be set aside for building a plant for producing by oxidation of ammonia about the equivalent of 24,000 lb. of 100 per cent nitric acid per 24-hr. day.

IV. That the War Department proceed at the earliest practical date with the construction of the oxidation plant and contingent upon satisfactory arrangements with the General Chemical Co. with the construction of the synthetic ammonia plant also.

V. That the Government negotiate with the Nitrogen Products Co. with the view to a contract for the right to use that company's patents and proceed with experimentation looking toward the industrial development of the Bucher process for production of ammonia through cyanide; and that contingent upon satisfactory arrangements as above a sum not over \$200,000 be allotted out of the nitrate supply appropriation.



FIG. 4. ONE OF TWO NITRATE HOUSES IN WHICH AMMONIUM NITRATE LIQUOR IS CRYSTALLIZED FOR THE MARKET. THIS LIQUOR HAS BEEN PREVIOUSLY MADE AT THE NITRIC ACID PLANT BY BUBBLING AMMONIA GAS THROUGH NITRIC ACID SOLUTION. U.S.N.P. NO. 1

VI. That out of the \$20,000,000 nitrate supply appropriation \$100,000 be allotted to active investigation of processes for the industrial production of nitrogen compounds, useful in the manufacture of explosives or fertilizers—this under supervision of the War Department.

VII. That in order to increase the production of ammonia and toluol the Government promote the installation of byproduct coke ovens by directing priority in production and transportation of materials and parts.

VIII. That the decision as to more extensive installation of nitrogen fixation processes and water-power development in connection with them be postponed until the plants above recommended are in operation or until further need arises.

IX. That while the preceding recommendations include all the measures that can now judiciously be taken for the fixation of ammonia, it is the opinion of the committee that the immediate accumulation and the permanent maintenance of an ample reserve not less than 500,000 tons of Chilean saltpeter is the measure most urgently necessary.

The foregoing report having met with general approval, the Secretary of War has directed the Chief of Ordnance of the Army to proceed to carry out the first six of the recommendations of the Nitrate Supply Committee and has announced that for the present the consideration of development of large water-power installations which had been begun by the interdepartmental

board (Secretaries Baker, Lane, and Houston), appointed by the President, would be suspended.

The outstanding feature of this program for action is the construction of the synthetic ammonia plant, using the General Chemical Co.'s process, which was largely developed by their engineer, Frederick de Jahn. As has been indicated, this process has already had trial upon a sufficient scale to demonstrate the practicability and to indicate as most probable its ability to produce ammonia at a very favorable price. In fact, in the search of the Nitrate Supply Committee for the best, cheapest, and most available means for the production of nitrates and other products that would be of use in the manufacture of munitions and in the manufacture of fertilizers this process appeared to give more promise of affording relief from dependence upon foreign nitrates for the defense of the country and more promise of a reduction in the cost of the nitrogenous constituent of fertilizer than others. Furthermore, this process is one which can be put into operation in a much less time than would be required to develop such a large water power as would be needed for other prominent processes available.

#### VALUE OF HABER PROCESS

The Bureau of Mines reported to the Ordnance Department, U. S. Army, on Jan. 27, 1917, the following observations in regard to the Haber method:

The technical control of the Haber process is of such great importance and requires so high a degree of training and skill that it is reported if the Badische people were to lose their present technical staff of experts, familiar with the process, many months would be required to train another staff capable of applying the process in practice.

The Haber process is not at present in use outside of Germany on account of the lack of detailed information regarding plant construction and operation, and also owing to the very large royalty demanded by the Badische Co. for its use by other concerns. It is, however, more than probable that the Badische Co. will itself install and develop the process outside of Germany when the war is ended.

Trustworthy information regarding the costs of production of ammonia by the Haber process indicates that pure anhydrous ammonia can be produced in liquid condition for a cost slightly less than 4c. per lb. It is improbable that any arrangement could be made for the United States Government to use the Haber process pending the conclusion of the European war. It is probable that when the war is ended the Haber process will be installed or will be available for installation in the United States. It is the cheapest process for the production of synthetic ammonia. It is independent of cheap power, the power being a small fraction of its cost. If desirable, it could be readily installed in moderate-sized units in connection with ammonia oxidizing plants at any munitions plant.

#### ADVANTAGES

1. Cheap ammonia.
2. Ammonia in water-free liquid condition ready for oxidation without purification.
3. Availability of raw material (air and coal).
4. Possibility of erecting comparatively small plants wherever needed.
5. Easy availability of product for transportation and for fertilizer.

#### DISADVANTAGES

1. Inability to procure technical details, use of method, and trained technical force without the assistance of the Badische Co., except as the result of many months and probably years of experimentation. This is largely owing to the difficult engineering problems involved in the use of pressure as high as 150 atmospheres and temperatures of 500 to 600 deg. C.-
2. High repair and renewal costs.
3. Undoubtedly high royalty that would be demanded if the Government were to install and operate this process itself. Inability to come to terms with the Badische Co. as to the use of its patents is reported to have been the sole reason for the non-adoption of this method by two large American corporations and one Norwegian corporation.

4. Patents and processes controlled in America by one corporation.

It is presumed that the Bureau of Mines report was prepared by Dr. Parsons. His prediction as outlined with regard to post-war installation in the United States is being fulfilled in the erection of the new plant at Syracuse, N. Y.

#### ESTIMATED COST OF PLANT NO. 1

The sum of \$3,000,000 estimated by the Nitrate Committee as being necessary for the erection of the process plant at Sheffield, Ala., was not in any sense a construction estimate, but based on figures submitted by the General Chemical Co. They were made by employing the best information available in the United States at the time.

Arrangements were made for the Government to take over the orders which the General Chemical Co. had placed in the market for apparatus to be used in a private plant the company had previously planned. Thus both time and money were saved.

#### ACTUAL TOTAL COST

The final value of the property known as U.S.N.P. No. 1 is recorded as \$12,689,677, including overhead charges, such as design, administration, freight, insurance, distribution system, roads, walks, etc. The am-

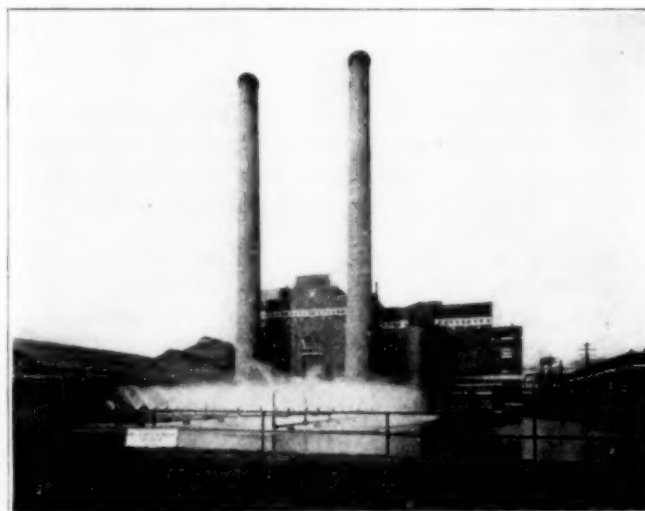


FIG. 5. POWER HOUSE AND COOLING POND. U.S.N.P. NO. 1

monia plant cost about \$5,592,000, the acid plant about \$2,184,000, the ammonium nitrate plant \$386,000, the power plant \$1,552,000, land and plant accessory buildings about \$1,406,000 and the permanent village for housing employees about \$1,852,000.

The process is practically erected complete, the exception being two units in the ammonia plant, which will await slight changes in design. The work has been discontinued for nearly a year, with only a small force for guard duty and maintenance work located on the property at the present time.

#### OPERATION TROUBLES

In describing the difficulties encountered during the operation period Colonel Joyes said:

The process depends upon the chemical reactions, which are very delicate. . . . Conditions have to be just about right, and to stimulate it so that the proper portion of the gases are synthesized a catalyst is used, and a catalyst in general is very subject to being poisoned and rendered inoperative by any foreign





FIG. 6. MACHINE SHOP, U.S.N.P. NO. 1, EQUIPPED TO HANDLE REPAIRS ON HEAVY AMMONIA PLANT APPARATUS

substance that may be in the gases. The General Chemical Co. had a catalyst they developed and that had given very good results in the laboratory tests. They had made the active material on a small scale, without much trouble, but when they commenced to produce it in quantities for use as a catalyst at this Government plant considerable difficulty was encountered.

Furthermore when the catalyst was put in the vessel at the plant and operation started, it was found to be very sensitive indeed toward all unfavorable conditions such as a slight amount of moisture or impurities in the gases.

We had trouble also with the apparatus. Some of the valves failed to hold the gases at high pressure. Some of the vessels exploded, especially one heater where the gases had to be brought up to an elevated temperature. Presumably the pipes in the heater were attacked by the gases, and we had a pretty bad explosion; we had a fire from it and so on. . . . The metal is eaten away, and we have samples of tubes which were exposed under those conditions and completely eaten away in a very short time.

The longest period of continuous operation of the ammonia plant was seventy-two hours. The total amount of ammonia produced, including all experimental runs, did not exceed thirty-four tons. The total amount of ammonium nitrate manufactured, including that produced from ammonia liquor shipped from coke plants, did not exceed eighty-five tons.

#### FUTURE PROSPECT FOR OPERATION OF PLANT NO. 1.

The successful operation of the Haber process at the Government plant is entirely dependent upon the action of Congress on the bills now pending for appropriations to carry on the necessary research work, both at the American University laboratories and at the plant in Sheffield, Ala. Funds are now available for continuation of the laboratory work until June, 1921. This research is very essential in order to determine the best catalytic material for the synthesis of ammonia, and the laboratory organization is now very actively engaged with extensive equipment, as will be described in a later article. The plant must be operated in conjunction with the research to perfect the process for commercial operation.

Henry Wigglesworth of the General Chemical Co. estimates that with the expenditure of less than a quarter of a million dollars for making changes and tuning up, Plant No. 1 can be made to work satisfactorily in producing ammonia. Whether this estimate is low or not makes little difference because the Ordnance

will have sufficient funds for vigorous prosecution of the work if the bills providing for the establishing of a Government nitrogen corporation are passed in Congress, according to estimates of George Roberts.

#### CONCLUSION

Aside from the opinions of the scientific investigators who have become enthusiastic over the possibilities of the Haber method, it is still considered by the more conservative technical men to be the coming process for nitrogen fixation, because of the lower cost of manufacture combined with the purity of product. This does not mean that the other methods of fixation are obsolete, but rather that if the industry is to be developed to keep pace with other nations we must look for the research in this process to be carried on by the Government.

The cyanamide process is the only practical and commercial method established in the United States today for the direct fixation of atmospheric nitrogen, and this fact should not be clouded by any plans as to the future. It is even possible that it may never be entirely displaced by another method. This may become more evident as new derivatives are discovered in making cyanogen compounds from cyanamide.

The Government officials will doubtless adopt a well-balanced policy with consideration for both present production and future development.

#### SOURCES OF INFORMATION

Final report of Nitrogen Products Committee, British Government.

Testimony before the Graham House committee, U. S. Congress.

Interviews with U. S. scientists and operators.

#### New National Hydraulic Laboratory Proposed in Buenos Aires

According to Trade Commissioner Brady the Argentine National University at La Plata has petitioned for a hydraulic laboratory to be used in experimental work by the engineering students. Already the Minister of Public Works has reported favorably on the project and has asked that a piece of land 975 ft. x 1,625 ft., in the Buenos Aires port between the East Canal and the Port Railway, be allotted for the construction of the laboratory. Final approval of the project will rest with the Argentine Congress at its next session in May. Efforts of American manufacturers in the past to introduce laboratory apparatus and machinery into the colleges of Argentina have not equaled those of their European competitors. Now an opportunity is offered them through the construction of this national hydraulic laboratory to place their equipment before prospective Argentine engineers.

#### Unique British Advertising Plan

The Federation of British Industries has devised a unique scheme for advertising home manufactures in all parts of the world. A new steamship, to be called the Federation, is to be constructed by some of the leading firms of the country as an exhibit of British marine engineering. The cargo of the ship will consist of various articles of British manufacture. Representatives of the firms interested will make the voyage for the purpose of showing their goods and interviewing foreign buyers.

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## Legal Notes

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BY WELLINGTON GUSTIN

### Conveyance of Property Subject to Mortgage

A victory was recently won by the Virginia Zinc & Chemical Corporation, Ltd., and others, in the suit instituted against them in the Virginia courts by C. B. Van Nostrand & Co. and others, when the Supreme Court of Appeals of Virginia affirmed the decree rendered in the lower court fixing liens and priorities as to claims against the forty acres of land upon which is located a manufacturing plant, situated near Bristol, Va., the property of John T. Williams, and postponing the judgment liens of plaintiffs to those of defendants and decreeing a sale of the property to discharge the liens.

It appears that John T. Williams executed a deed of trust in 1912 to the Windsor Trust Co., conveying the above property to secure seventy-five \$1,000 notes, bearing 6 per cent interest, payable semi-annually, for the purpose of negotiation to realize money to discharge his liabilities. At this time there was a prior mortgage on the property to secure a note for \$8,500. Both of these deeds were duly admitted to record. On Dec. 31, 1913, by agreement the parties changed the date of the seventy-five notes to Oct. 1, 1913, payable one year after date. This agreement was recorded Jan. 31, 1918.

To relieve his pressing indebtedness, John T. Williams, acting through his son John T. Williams, Jr., induced Mrs. Nellie B. Crouch of St. Louis, Mo., mother-in-law of the son, to purchase his note for \$33,000, secured by the seventy-five \$1,000 notes, for which she paid \$30,000 in cash. Through her husband, Mrs. Crouch became the owner of the note of \$8,500. From the cash obtained Williams paid off the \$8,500 note, the balance being applied to payment of his other liens and debts. In 1914 Mrs. Crouch purchased an additional note for \$5,500 and another for \$500, and in 1915 she paid delinquent taxes and insurance premiums on the property for Williams, aggregating \$1,417.42, for which he made his note. The total notes of Williams thus held by Mrs. Crouch amounted to \$40,417.42, all secured by the same issue of notes as collateral security.

In 1914 John T. Williams and wife executed a deed transferring and conveying the forty acres of land and manufacturing plants to the Virginia Zinc & Chemical Corporation, subject expressly to the deed of trust securing the seventy-five \$1,000 notes.

### SALE OF PROPERTY AND CONTENTIONS OF PLAINTIFFS

The notes given to Mrs. Crouch contained a provision empowering the holder to confess judgment for the maker for the amount due thereon "and to sell or cause to be sold any or all of said collaterals, or any substitutes therefor, or additions thereto, at public sale upon such notes, at such place, and on such terms as the holder of said notes," etc., may deem proper, applying the proceeds to the discharge of the liability due the holder. The holder under any such sale was permitted to become the purchaser without any right of redemption. After default on the notes they were sold at St. Louis, after due notice and publication, and Mrs. Crouch became the purchaser at the price of \$10,000. Deduct-

ing the expense of the sale, the balance was entered as a credit on the demands due her of \$33,000.

John T. Williams, Jr., as trustee of the real property, advertised it for sale under the deed of trust. C. B. Van Nostrand & Co., Packard & Co. and others having judgments against the Virginia Zinc & Chemical Corporation, recovered in the Circuit Court, asked for an injunction preventing the sale as advertised by Williams, Jr., and for an accounting of the property, the liens thereon with their priorities and the sale of the property to satisfy these liens. The court ordered an accounting and fixed the liens and priorities, postponing the judgment liens of plaintiffs to the trust deeds and liens of Mrs. Crouch and the Virginia Zinc & Chemical Corporation. From this decree the plaintiffs appealed, contending (1) that the deed conveying the property in question to the Virginia Zinc & Chemical Corporation vested the title thereto in the chemical company, which could not be affected by the subsequent recording, in 1918, of the agreement of Dec. 31, 1913; and (2) that this agreement of Dec. 31, 1918, as well as the deed of trust covering the seventy-five notes, was fraudulent as to the judgment creditors of Virginia Zinc & Chemical Corporation, and should be declared null and void.

### COURT ANSWERS PLAINTIFFS' CONTENTIONS

Answering the first contention, the Supreme Court of Appeals said there was no proof that the rights of the plaintiffs were affected by the failure to record until Jan. 31, 1918, the agreement dated Dec. 31, 1913, changing the date of the notes secured by the mortgage. It was not necessary to record this paper at all. The change of date in no way affected the debt secured. The mortgage remains a lien until the debt it was given to secure is satisfied, and is not affected by a change in the note. And, again, it was claimed that as there was no debt at the date of the execution of the seventy-five \$1,000 notes, the deed of trust therefor was invalid. But the court said this claim was without merit, for in the business world nothing is more common than the execution of such securities in contemplation of a loan. As soon as a note is negotiated, the liability to take care of it arises, and the holder's right to the security attaches.

On the second contention, that the instruments were fraudulent as to judgment creditors of the corporation, these were subsequent creditors, and, having contracted their debts and recovered their judgments against the purchaser of property conveyed subject to a mortgage of record, their judgments were recovered with constructive notice of the nature and extent of their debtor's interest in the mortgaged property. Hence they cannot complain of the mortgage as being fraudulent as to them.

### London Metal Prices for Twenty Years

An interesting and instructive chart has been compiled by Vivian, Younger & Bond, of London, showing the prices on the first day of each month during the past twenty years (1900 to 1919, inclusive) of spelter, standard copper, tin, soft lead without silver, standard silver, and Scotch and Cleveland iron. The chart also shows the British bank rate prevailing at various dates during the same period, and the highest and lowest prices in each year of the metals enumerated—in which very considerable fluctuations are recorded.



## Scientific Control of the Filter Station—II

A Discussion on the Rate of Flow of Filtrate—Critical Pressure—Graphical Analysis of Rate and Amounts of Flow—Influence of Temperature and Density Changes—Use of Filter-Aids in Filtering Colloidal Materials\*

By ARTHUR WRIGHT, M. E.

THE maximum capacity of filtrate outflow from a filter is the goal of every ambitious operator, and some ingenious efforts have resulted in failures due to an incomplete comprehension of the underlying principles.

The attack most often pursued is to increase the filtering pressure. This is logical, for the filter medium and the cake can be considered multiple orifices, so that the law applies that the flow through an orifice is proportional to the pressure. That an increase of the pressure thus increases the quantity of filtrate is not universally true. It is practical with almost theoretical accuracy when handling solids of a crystalline or granular texture. It is true to a certain extent with every material, but with some only through a small range of pressure. Those with the smallest limits are flocculent precipitates with which a few feet increased head of gravity feed is all that will increase the flow before a contrary result is obtained.

Increased pressure is identical with increased suction when operating vacuum filters. There have been misconceptions on the difference of pressure and vacuum filtration. Much discussion has arisen over the merit of "pushing" the liquid through the filter as is the case with pressure type machines, and "drawing" it through with vacuum filters. The action here is not analogous to that of the familiar law of mechanics where a cane can be drawn along a pavement easier than it can be pushed along. The action in pressure and suction filters is identical, for the filtering force in either case is the difference of pressure on the two sides of the medium, in the one case it being the pressure due to a pump or head greater than atmospheric pressure; in the other that of the atmosphere compared to a pressure lower than atmospheric. In consequence laws pertaining to pressure filtration apply also to vacuum filters, although the range of difference in pressure is limited to 14.7 lb. per sq.in. as the theoretical maximum with the latter.

### CRITICAL PRESSURE

The reason that, in practice, the law of increased pressure does not always increase the flow is found in the fact that for every material there is a pressure above which an increased flow is not obtained, but a decreased flow is had instead. This is known, in filtration parlance, as the critical pressure for that material. Confusion sometimes occurs on this point, for an operator will, after filtering at a given pressure, jump his pressure up and point to the larger stream discharging from the filtrate outlet. Unfortunately for him the flow does not last long. It is occasioned by the fact that the increased force compacts the cakes on the leaves and forces the entrained liquid out through the filter cloth.

After this momentary rush, however, the rate is lower. It is difficult to estimate the critical pressure for the various materials handled in industrial filtration or even for any one material, for local conditions surrounding the precipitation of the solids or handling can widely affect its filtering characteristics. It is not, however, difficult to ascertain the critical pressure in any plant if experimental runs be made with periodic readings of the flow filtrate taken and all the other factors as affect the rate of flow maintained constant. With these readings it is simple arithmetic to figure the rate of flow per unit area for the successive periods at which the readings were taken. A graph then can be plotted, the abscissæ being the time of filtration and the ordinates the rate of flow. It is interesting to find how completely experimental observation is corroborated by such a plot.

### GRAPHICAL ANALYSIS OF RATES OF FLOW

Representative curves are shown in Fig. 1. *AB* is that of a liquor containing crystalline solids or materials of similar texture which are free filtering products. This is practically a straight line slowly breaking into a hyperbola, and the interpretation is that the rate of flow falls off at equal increments, each increase in thickness of cake causing a corresponding increase in the resistance to the flow. The statement that "it is a straight line" is approximate and true only when applied to the usual working limits. The line eventually bends and resolves itself into a hyperbola, slowly approaching but never reaching zero. This curve represents that of the easiest filtered materials.

The curve *CD* is typical of the vast majority of difficult materials handled. The initial flow is high, with a rapid fall until a low rate is obtained, decrease in which is small. The goal of every filter experimenter is to change the form of this graph and make it approach *AB*. *EF* will represent the fruit of such efforts and in lay language means that by a modification of the material as precipitated or by modifying the method of handling the material it is changed to a more easily filtered liquor.

To some, such a discussion may seem too academic and when incorporated as the results of a test a graph is often somewhat superfluous, but to the experimenter working out the problem it is of inestimable value. It is a big factor in maintaining a broad point of view and prevents premature satisfaction when better results are to be obtained by means of further research.

There is a considerable amount of additional information to be had from a study of these curves, such as a point of flexure indicating the economical length of cycle, computation of capacity by planimeter methods, etc., but such data are better obtained by other methods, as will be elaborated upon. The principal help from

\*For Part I, see CHEM. & MET. ENG., vol. 22, No. 22, 1920, p. 1,015.

these graphs is in noting their general curvature or shape and comparing the curves obtained from modified operation with that of a previous run. In this respect, they serve a most useful purpose, for with all factors kept constant, save a modified pressure, these graphs are indelible proof of the existence of a critical pressure and the most definite means of obtaining it.

#### INFLUENCE OF TEMPERATURE AND DENSITY CHANGES

What is true of pressure being an important factor in the rate of flow is equally true of the temperature of the slurry and density of the liquid at which it is filtered. Here we have to deal not with a critical temperature or density of filtration, for with most materials practical economy dictates this before the limit which filtering efficiency requires is reached. The hotter the

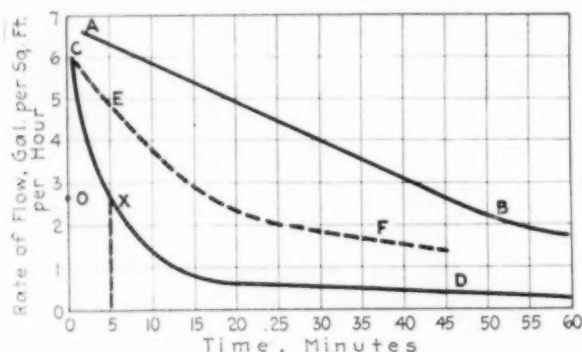


FIG. 1. RATE OF FLOW CURVES

liquid is the thinner it becomes and the better will be the rate of flow. For the proper determination of the right temperature and density the costs of heating, evaporating, and maintaining the heat must be had so as to balance the increased work of the filters. It is, however, too often unappreciated that there is a very rapid rise in the viscosity with increased density and decreased temperature as shown in Figs. 2 and 3. In Fig. 2 it is quite apparent that below Y a few degrees difference does not greatly affect the viscosity, but around X 2 or 3 degrees difference in temperature marks a distinct difference. Such information is of course not due to filter development, but is of value to the operator and teaches him the need of a nice control of temperature and density.

#### THE ECONOMICAL FILTERING PERIOD

In practically all phases of filtration discussion the rate of flow is synonymous with cake building. It is apparent that if a dry, hard cake is desired from a plate and frame filter press the frames should be designed so that the cakes on the two sides of each frame shall join together before the rate of flow has fallen off too greatly. If the time required to build the frame solidly full is too prolonged, the cycle is bound to be uneconomical.

A further study of the curve CD shows us that if it were possible to work this material only for the time represented by OX we would be working at the economical part of its filtration. Such a scheme means, however, short filtering periods and is feasible only in those types of filters wherein automatic discharge and continuous operation are had. Here we find the fundamental principle of continuous vacuum filtration and while possibly in a sense this is not ways and means of bettering the rate of flow, it is basic in that maximum

capacity is had not by a modification of the filtering characteristics of the material being handled but by a mechanical device to meet the conditions of the material "as is." This has its importance when materials are not subject to temperature or density variation and it is required only that the deposit of the solids shall have a sensible thickness and be efficiently discharged. It is true that most applications of continuous vacuum filters are on materials of a free-filtering character, but the basic idea is as explained nevertheless.

The total flow curve is often used and from it capacity is read directly. Its curvature is not as sharp as in the rate of flow curve and is consequently not quite as informative as the latter. The curve is the simple plot of time of filtering as abscissa and total flow at time of reading as ordinate as shown in Fig. 4. Too long a filtering period is cumulative in its evil effects. Washing is slower, cake hardness less and the chance of a clean cleavage of the cake from the filter cloth jeopardized. This fault of an uneconomical cycle due to the width of the frames in plate and frame presses being too large is entirely too prevalent throughout industrial filtration and is due to inadequate determination of the filtering characteristics of the material being handled.

One advantage in leaf type filters is that it is not necessary to continue the filtration until a hard cake is obtained. This means then that the filtration can be discontinued at any time without jeopardizing the dryness of the cake. It is in these filters that the operator is afforded the most opportunity to effect best results as regards maximum capacity. The point to be kept in mind is that the rate of flow is constantly decreasing and when working at the low point of the curve the outflow

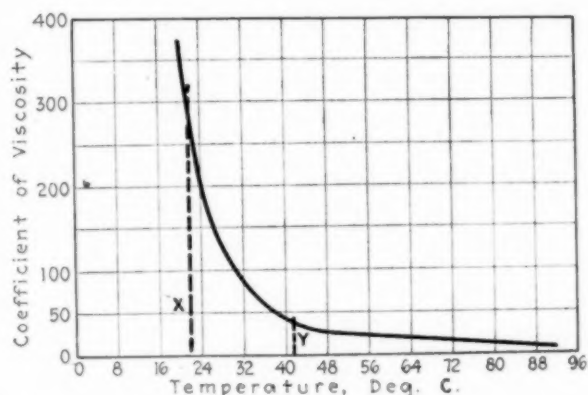


FIG. 2. TEMPERATURE VISCOSITY RELATION

is not commensurate with the time required. There will be discussed in a later paper a mathematical means of determining the economical length of cycle which gives consideration to the washing, drying and discharging periods, but it is well to have in mind the general character of the rate of flow curve.

#### HOMOGENEITY OF CAKE IMPORTANT

Oftentimes liquors have to be handled in which the solids of suspension are a mixture of coarse and fine particles. For maximum rate of flow agitation must be maintained in the filter so that the deposit both at top and bottom of filter medium is made up of the mixture of coarse, free-filtering solids and the fine, more difficult-filtering material. If classification takes place so that the lower part is coated with the coarse material



and the upper part with the fine, then tapering cakes are sure to be formed and all the evils of discharging, warped leaves, etc., will ensue. This leads to a point for further consideration, for if the liquor in the filter classifies and filtration is started, no amount of agitation from that time on is of any practical value. The solids that build up the cake are carried to their positions by their respective stream lines. When a cake becomes highly resistant to filtration so that the flow is cut down, the stream lines of the liquid are weak and can carry particles only that are easily moved. This is the case when the upper part of the leaves become coated with the finer particles of suspension. No amount of uprising current which will carry the coarse particles upward can aid the deposition of the heavier particles at the top of the leaves. The stream lines are at right angles to the filter surface and strong stream lines are necessary if the velocity is to be sufficient to deposit the coarse particles on the cake surface. The above, therefore, emphasizes the fact that the initial deposit on the filter medium is vital if the best rate of flow is to be obtained. There is a corollary to the last statement; that the initial pressure should not be excessive. The reasoning on this is that too high an initial pressure compacts the first deposit so as to make it too resistant and lowers the capacity. Fortunately, low initial pressure is common practice, for if the pump is not too large the initial outflow of filtrate will approximate the throw of the pump and the pressure will rise slowly. It is only when an excessively large pump feeds the filter that the rise in pressure is rapid and this trouble is encountered.

The initial resistance of the filtering fabric, drainage member, etc., should be as low as possible. This fact is apparent but has been over-emphasized in some designs of filters in which excessive drainage has been provided. It must be remembered that the filtrate issues through the fabric in drops, the accumulation of which produces the filtrate flow. The drainage does not have to be very great to meet this requirement, however. In the matter of choice of filter medium, more attention is required. The demand is for one of low resistance to the passage of the liquid through it and if mechanical wear calls for a heavy cloth, then one of open weave is required. If too dense a cloth is used, the velocity of the initial stream lines causes the finer particles of suspension to be forced into the weave of the cloth and to imbed themselves so as to cut off the porosity. With coarser weaves of filter cloth these fine particles pass through the interstices and issue from the filter as cloudy filtrate which must be refiltered. This is far better than having the filter cloth clogged so that it decreases the flow and cannot be effectively cleaned on discharging.

It is quite evident that the filter cloth must be retained in a free-filtering condition if recurring runs

are to show the same capacity as the first run. It is idle to point out that thorough discharge of the cakes from the cloth is required for maintaining high rate of flow, but it is a point that experimenters are often too quick to assume when dealing with a new material. Inspection of the surface of the cloth is not an infallible means of determining that the cloth is clean. The rate of flow on succeeding runs is the only safe way.

#### STEADILY INCREASING PRESSURE DESIRABLE

It is becoming better recognized that a constant or steadily increasing pressure is the most desirable for obtaining the best rate of flow. Fluctuations in pressure produce an effect similar to that of tamping wet ground. The cakes are made denser and more resistant by this action. The interval in which the pressure falls is one of inefficient working, for the resistance produced by the high pressure is too great for the lower pressure rapidly to force the liquid through. This point is one of the favorable factors in the use of montejus and pneumatic eggs, gravity feed and vacuum receivers, etc. Centrifugal pumps with rotors easily accessible and with sufficient clearance to allow the pumping of coarse and gritty materials are admirable in that the pressure is in reverse proportion to the amount of filtrate flowing. This type of pump is not best when handling flocculated material, for as soon as the outflow is less than the throw of the pump the rotor has a churning action and breaks up the flocculent precipitate. Every chemist knows how much harder it is to filter such precipitates after agitating and stirring them so as to break up the agglomerated particles than when handling the material with the flocculent condition preserved. By reason of the points above outlined positive discharge rotary pumps are gaining an increased use and have characteristics well suited to filter press work.

Colloidal material or solids so fine as to approximate colloidal conditions are most difficult to handle with any degree of satisfaction or economy. They are difficult

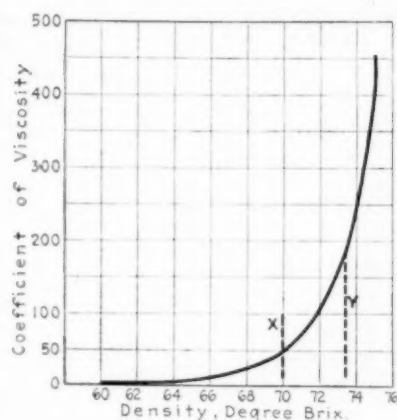


FIG. 3. DENSITY VISCOSITY RELATION

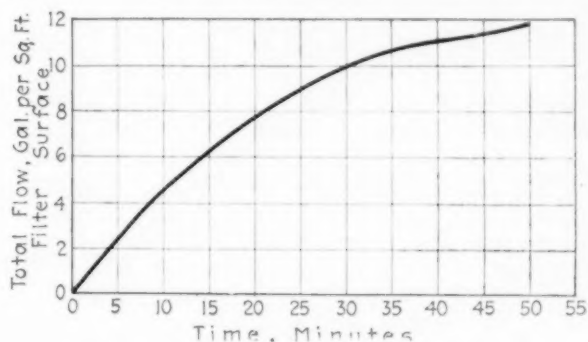


FIG. 4. TYPE CURVE OF TOTAL FLOW

to clarify unless an auxiliary filter medium be employed and form so compact a deposit as to be almost impenetrable. Fortunately, in the majority of cases, these solids are waste products and can be coagulated or will allow of the introduction of a filter-aid. The usual method of coagulation is by the production of a flocculent precipitate by chemical reactions. Enough attention to this point seems to be lacking, for too often the goal seems to be to add enough reagents to be able to note a sparkling liquor between the separate flocculent particles. It does not seem to be appreciated that an excess precipitate adds to the solids of suspension which are of themselves difficult to filter in pressure filters.

It must not be inferred that the agglomeration of the

particles of suspension does not aid in pressure filtration, although this theory is sometimes advanced. There is no question that flocculation is the best means of obtaining this agglomeration of the colloidal material, but the demand is satisfied when the quantity of reagents produces no excess precipitate. This, of course, has not the same importance when only decantation methods of clarification are employed.

#### USE OF FILTER-AIDS IN FILTERING COLLOIDAL MATERIALS

There is a new theory for the clarification of contrary liquors that is demanding more attention and deservedly so. If there is added to the liquor before its filtration a quantity of inert free-filtering material, it is obvious that the deposit on the filter cloth is a mixture of the free-filtering solids and the contrary precipitates. The former build up so as to preserve the porosity to a greater extent than do the latter and consequently admit of a greater flow of filtrate. The material so added is known as a filter-aid and must conform to the three specifications of being (1) inert to the liquor, (2) of a free-filtering character, and (3) of such a specific gravity that it can be handled in the filters without settling or floating.

The filter-aid is added with the idea of decreasing the resistance of the solids deposited and making the liquor free-filtering, similar to that which carries crystalline or granular solids of suspension. It has been demonstrated that only a small percentage is necessary to effect marked results, but true filtering efficiency dictates the use of quantities in excess of that generally added. It is worthy of note that when good capacity flow is obtained from a filter, a corresponding increase in the volume of the cake is obtained. The greater the bulk of the cake, the better its discharge and the filter-aid therefore simultaneously affects not only the rate of flow but the equally important factor, efficient discharge.

It would seem that the combination of the flocculating idea and the filter-aid principle ought to have possibilities. It has. The idea, however, must not be to add the filter-aid as an aid to the filtration of a liquor the solids of which have been agglomerated, for to do so only partly solves the problem. In plant practice but few instances will be found where a flocculent precipitate will not be broken up by the time the liquor enters the filters. The answer is to use the filter-aid to strengthen the structure of the flocculent precipitate by adding it to one of the defecants before its addition to the liquor. This will often require diluting the defecant, and if the water required for this is objectionable on the score of increased evaporation, no objection can be found to substituting clarified effluent for the water.

To thicken the liquor by decantation methods so as to concentrate the solids makes for increased duty of the filter. This is universally true as regards its capacity in cake discharged, although there are instances where the rate of flow is also increased. The latter as explained in that classification is minimized and the granular particles deposit along with the fine so to preserve the porosity to a greater extent. Continuous filters often are applicable on liquors that have been thickened where they are impractical prior to decantation, and there are numerous instances where this has proved the economical means of handling this material.

*(Part III, dealing with Washing and Drying, will be published in a subsequent issue.)*

#### Maple-Products Industry of Quebec Province

Official reports show that the maple-products industry in the Province of Quebec has grown markedly during recent years, its development being mainly attributed to the scarcity and increased price of beet and cane sugar. While sugar maples are found chiefly in the central and western sections of the province, the industry has to some extent developed also in the Gaspé Peninsula, the counties of Bonaventure and Gaspé showing in 1919 an output of 59,135 lb. of sugar and 3,101 gal. of sirup, as compared with an output in 1911 of 11,870 lb. of sugar and 512 gal. of sirup. No figures as to quantities are available for the county of Matane, but the products in the three counties of 1919 were valued at \$20,665.

The output in the province as a whole in 1919 amounted to 12,353,667 lb. of sugar and 1,470,275 gal. of sirup, of an estimated value of \$6,396,535, as compared with the 1911 output of 9,989,443 lb. of sugar and 1,005,330 gal. of sirup, of an estimated value of \$1,680,393. Maple sugar ten years ago sold for 7c. to 8c. a lb. and in 1918 at an average price of 15c. a lb. The latter part of 1919 25c. to 30c. a lb. for sugar and from \$2 to \$2.50 a gal. for sirup were offered. The United States affords the best market for the product.

#### PRIVATE AND GOVERNMENT AID TO INDUSTRY

An organization known as the Co-operative Society of Pure Maple Sugar and Sirup Makers, organized some years ago, has secured as members thousands of farmers interested in this industry. Its objects are to distribute information among its members as to the best methods for obtaining the highest quality of products and to prevent their adulteration. Through the efforts of this association a Federal act was passed prohibiting adulteration of maple sugar and sirup, and it was also responsible for the establishment of sugar-making schools, and for exhibitions and competitions in Canadian maple products.

The development of the industry has been further stimulated by the provincial Department of Agriculture through demonstrations in sugar making in various parts of the province given by skilled instructors.

The province has three sugar-making schools located at La Minerve, Beauceville and Ste. Louise. These schools provide a fifteen days' course, the Department of Agriculture paying the board of the students. Last season at these three schools 12,000 maple trees were tapped and 808 gal. of sirup, 3,775 lb. of sugar, and 100 lb. of taffy were manufactured. Thirty-three pupils followed the course, and there was an attendance of 786 visitors. The approximate period of the course, depending upon the season and location of the school, is from March 20 to the latter part of April.

#### DOMINION GRANT TOWARD COST OF INSTRUCTION

The 1919-20 allotment to Quebec Province from the Dominion Government, under the agricultural instruction act of Canada, for educational purposes in connection with the maple industry was \$4,000.

As the farmers depend to a considerable extent upon the lumbering industry for employment in the winter, which employment terminates about the end of March, and as farm work usually does not commence until the middle of May, the maple-products industry fits in nicely with their other work.



## Reinforced Lead

BY CHARLES BASKERVILLE AND C. M. WALES

**L**EAD suspended in large sheets or pipes creeps or sags, so that it must be held in position. Frequent supports without (as with sulphuric acid chambers, lead ducts for sulphur gases, tank cars, etc.), lead-coated iron braces within (as in linseed oil refining kettles), or supporting retaining walls of masonry within (as with pulp digesters, petroleum refining tanks, etc.) are necessary to hold the lead in place. Vacuum pans and connections of lead must be of extra thickness ( $\frac{3}{4}$  to 1 in.), hence of great weight, to prevent collapsing.

Iron and steel pipe with lead lining is extensively used, the lead protecting the iron or steel, the latter also preventing bulging of the lead when the necessary pressure is applied within to move the liquids thus transported. Lead has been flowed or burned on other metal, but each method fails in one way or another, primarily in the cost of installation.

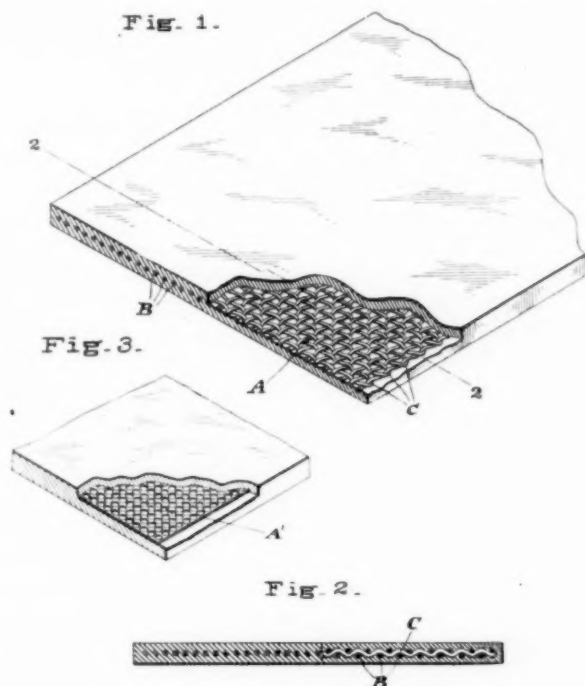
Many of these troubles in the use of lead have been entirely overcome and others materially diminished by reinforcing lead with iron or steel wire gauze or perforated sheets, which are imbedded within the lead (U. S. pat. 1,280,908 and 1,280,909).

Fig. 1 is a perspective view of an article partially broken away. This figure shows a portion of a lead sheet which is reinforced by a ferrous gauze.

Fig. 2 is a cross-sectional view taken as on the broken line 2-2 of Fig. 1.

Fig. 3 is a perspective view of an article partially broken away. This figure shows a portion of a lead sheet which is reinforced by a perforated ferrous plate.

The elastic limit has been increased four to five fold and the tensile strength has been increased two to three fold. The variations observed were due to differences in gage of wire and mesh of gauze used.



FIGS. 1 TO 3. REINFORCED LEAD SHEET

Fig. 1. Perspective view of a lead sheet reinforced by a ferrous gauze

Fig. 2. Cross-sectional view 2-2 of Fig. 1.

Fig. 3. Perspective view of a lead sheet reinforced by a perforated ferrous plate

Both may be materially increased by increasing (within limits) the gage and looseness of weaving the gauze. When manufactured, the surface of the lead or lead-alloy may be somewhat rough and unnecessarily thick. Both are easily remedied by rolling, as in making sheet lead. Lateral extension of 20 per cent and elongation of 30 per cent have been obtained, the main care being against tearing the reinforcing wire gauze. Sheets 4 ft. 6 in.

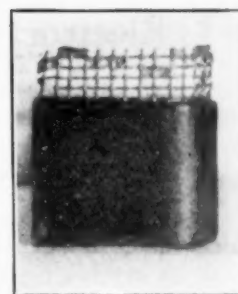


FIG. 4. BENT PIECE OF REINFORCED LEAD SHEET

x 5 ft. 6 in. have been made. For obvious reasons smoothing the surface is advisable only when the reinforcing member is perforated sheet iron or steel.

The reinforced sheets may be bent or shaped almost at will, as the lead does not fracture when bent (see Fig. 4). The sheets may be cut and joints are easily burned together in the same manner as ordinary sheet lead is burned (see Fig. 5).

The lead may be easily melted from an edge of a sheet and the piece shaped into pipe, the overlapping edge being then burned in position. A pipe, 8 in. in



FIG. 5. JOINT PIECES OF REINFORCED LEAD SHEET

diameter, made up of reinforced lead 0.2 in. thick, collapsed at 85 lb. per sq.in. pressure.

The experimental work on this material was carried out by V. A. Belcher.

College of the City of New York.

### American Cotton Seed and Cottonseed Products

The cotton seed received at American mills during the nine-month period Aug. 1, 1919, to April 30, 1920, amounted to 3,963,472 tons, as compared with 4,218,138 tons in the corresponding period of 1919, according to a preliminary report of the Bureau of the Census. This does not include 23,725 tons and 40,438 tons on hand Aug. 1, nor 163,546 tons and 124,743 tons reshipped or destroyed for 1920 and 1919, respectively.

The amount of seed crushed during the nine-month period was 3,883,368 tons in 1920 and 4,084,710 tons in 1919. There was 103,829 tons on hand at the mills on April 30, 1920, as against 173,866 tons on April 30, 1919.

Imports of cottonseed products amounted to 13,285,430 tons during the nine months ended April 30, 1919; figures for the corresponding period of 1920 are not available.

Exports during this period totaled 125,826,783 lb. of oil, 210,641 tons of cake and meal, and 40,136 running bales of lint in 1920, against 120,347,205 lb. of oil, 119,054 tons of cake and meal, and 65,046 running bales of lint in 1919.

## Electrochemical Notes From Scandinavia

### NEW SODA FACTORY IN NORWAY

Recently the Norwegian Hydro-Electric Saltpetre Co., which works the arc process at Notodden and Rjukan, has started a factory to make soda with which to combine the nitrous gases that pass over from the nitric acid absorption towers.

The plant has cost several million kroner and it starts with a production of 27 long tons per day. By it the company will be independent of outside sources of basic material and will be able to secure still further its position in the supply of pure sodium nitrate and sodium nitrite.

It is not generally known that for some years sodium nitrate has been made by the arc process in Norway and sold in England and elsewhere in competition with Chilean nitrate. The Norwegian product is readily absorbed by the market because of its exceptional purity.

### SODIUM NITRITE FOR DYE INDUSTRY

Sodium nitrite made by the electric arc process in Norway is again coming into the United States in quantity, a firm in New York City having contracted for at least 6,000 tons per annum for several years. The Norwegian Hydro-Electric Saltpetre Co. is easily able to control this trade because the sodium nitrite is of the nature of byproduct, inasmuch as it is made by the gases which are not absorbed to form nitric acid.

The Badische Anilin und Soda Fabrik established a factory at Christiansund about nine years ago for the special purpose of supplying its German dye-making plants with sodium nitrite.

The only factory making nitrites from arc in the United States is the Nitrogen Products Co. of Seattle; its output is in the form of sodium nitrite and most of it goes to dye works in Japan. Needless to say, the plant at Seattle is an arc plant.

### DR. SAMUEL EYDE

It will be of interest to engineers and electrochemists all over the world to learn that one of the new Ambassadors to Poland is the well-known Norwegian engineer, Dr. Samuel Eyde, whose persistence and large vision has done much to build up the great air nitrate plants at Notodden and Rjukan. Both Poland and Russia require immense quantities of nitrogenous fertilizers and it is not unlikely that this appointment may lead to very intimate trade relations with Norway, especially in these chemical products.

### CARBIDE AND CYANAMIDE PLANTS IN NORWAY

A new cyanamide plant built in Norway during the war in which the Union Carbide Co. and McKlouman are interested has been closed down. It will probably not be restarted because the power—about 70,000 hp.—is being contracted out to various surrounding municipalities.

The position of carbide and cyanamide plants still running is chaotic and many are partly closed down so as to reduce their operating losses.

There seems to be no doubt that the synthetic methods of producing ammonia and the increasing production of byproduct ammonia will supplant the cyanamide method

of making ammonia, a situation which would have occurred some time ago but for the war bringing about abnormal conditions, and preventing information coming from Germany as to the Haber process.

### SWEDISH CYANAMIDE CO.

Recently there has been a considerable fall in market value of the shares of the Swedish Cyanamide Co. This is probably traceable to an invention of Dr. Cederberg of Stockholm University which has been purchased by the Norwegian Hydro-Electric Saltpetre Co. The invention has to do with the manufacture of ammonia and the Norwegian Hydro-Electric Saltpetre Co. is now working out the process in its experimental laboratories.

Before the war the Norwegian concern depended on England for ammonia with which to make ammonium nitrate and when the war made transport difficult it obtained ammonia from cyanamide made at Odda. It still uses some of this, but byproduct ammonia liquor is again going over from England in considerable quantity.

It is probable that the Norwegian company will some day make its own supply of ammonia.

### WAGES IN NORWAY

In these days when so many people are wasting their time bemoaning the tendency toward higher wages it will come as a surprise to find that some laborers in Norway are probably paid higher wages on the average than those in any other country in the world.

It is only comparatively a short time ago that boatloads of workers were leaving Norway to find homes and better paid occupations in the United States and Canada, and many cities have sprung up which are almost entirely populated by Scandinavian people.

The tendency now, however, is for Norwegians to remain in their own country because it is going ahead at such a very rapid rate and money has accumulated until now Norwegian financiers are prepared to back with ready cash practically any scheme that the electric engineers of that country place before them.

### Use of Granulite in the British Glass Industry

The American Chamber of Commerce in London reports that an important discovery of granulite has been made, on the northern borders of Dartmoor, near Okehampton.

Granulite contains not only silica, but potash and soda—all of which are necessary in glass making—and gives the best results in the production of glassware of the highest quality. It is said that glass bottles and jars will be made cheaper here than anywhere in the world, as the cost of the material used on the spot will be only 15s. a ton, in comparison with the price of £2 a ton of the cheapest material ordinarily used. The material is reported as being specially suitable for the manufacture of cast and pressed glass articles and window glass. It is also of value in the manufacture of enameled metal ware and electrical insulators of various shapes. Even the waste heaps can be turned to account, for the black stone which was formerly considered suitable only for road material can now be used for making beer bottles (luckily, "Pussyfoot" has not yet been successful in England).

It is reported that English glass manufacturers will be in a position to compete on favorable terms in the neutral markets of the world.



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## Synopsis of Recent Chemical & Metallurgical Literature

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**Dehydrogenation of Primary and Secondary Alcohols by Catalytic Oxidation.**—A general method of preparing aldehydes and ketones is given by CHARLES MOUREU and GEORGES MIGNONAC in *Comptes Rendus*, vol. 170, No. 5, pp. 258-261. During their work to transform secondary butyl alcohol into methylethylketone they have worked on the dehydrogenation by catalytic oxidation using first copper and then silver.

They have found that silver acts as an excellent catalyzer and that it can be used indefinitely, and they have generalized its use for the dehydrogenation of different alcohols. The catalyzer is prepared by precipitating the silver in a very finely divided state from the nitrate solution by formaldehyde on asbestos. The operation is as follows:

The catalyzer is placed in a tube and brought to a temperature of 230 to 300 deg. C. A thermocouple is introduced in the mass of the catalyzer to regulate the temperature within the required limits. In the mixture of air and alcohol vapors passing through the catalyzer the proportion of air is somewhat less than that theoretically required. Oxidation takes place immediately. The operation being exothermic, the temperature has to be controlled, because at higher temperatures the products formed are decomposed. To avoid this decomposition and to render the operation more regular they proceed by fractional oxidation with the use of two catalytic masses in series. A mixture of alcohol vapor and air in quantity notably inferior to the calculated quantity needed (40 to 50 per cent only) is passed over the first catalyzer mass; the products resulting are passed over the second catalyzer mass, where they meet the required supplement of air, and the final product is obtained. The operations are thus very regular, and the temperatures easily kept within the most efficient limits. In some cases there may be a series of more than two catalyzing masses.

They have treated nine alcohols and obtained the corresponding aldehydes and ketones with an efficiency of 60 to 96 per cent.

**Treatment of Methyl Alcohol:** Used two catalyzing masses, temperature maintained at 360-400 deg. C. Efficiency in formaldehyde 62 per cent. Carbon monoxide, hydrogen and carbon dioxide are present in the escaping gases.

**Treatment of Ethyl Alcohol:** Used two catalyzing masses, temperature maintained at 340-380 deg. C. Efficiency in acetaldehyde 89 per cent without any appreciable formation of acetic acid. In the escaping gases there are present 3 to 5 per cent carbon monoxide and 0.5 to 1 per cent carbon dioxide.

**Treatment of Normal Butyl Alcohol:** Used two catalyzing masses; temperature maintained at 330-350 deg. C. Efficiency in butanol 93 per cent.

**Treatment of Amyl Alcohol:** Used two catalyzing masses; temperature maintained at 330-350 deg. C. Efficiency in the corresponding aldehyde 94 per cent.

**Treatment of Allyl Alcohol:** Used one catalyzing mass, the quantity of air used being only two-thirds of that theoretically required. Efficiency in acrolein 70 to 75 per cent.

**Treatment of Benzyl Alcohol:** Used one catalyzing mass and a quantity of air less than that theoretically required so as to avoid an excessive increase in temperature of the catalyzer. When working at 300 deg. C. the proportion of the corresponding aldehyde obtained depends on the quantity of air used. During one passage about 40 per cent of the alcohol is transformed into aldehyde with an efficiency of 80 per cent of the transformed alcohol.

**Treatment of Cinnamic Alcohol:** Treated in the same manner as for benzyl alcohol. Efficiency in the corresponding aldehyde 60 to 70 per cent.

**Treatment of Isopropyl Alcohol:** Used one catalyzing mass. Efficiency in ketone 90 per cent.

**Treatment of Secondary Butyl Alcohol:** When using one catalyzing mass the efficiency in ketone is between 90 and 95 per cent. Better results are obtained by fractional catalyzing, when the operation is easier to handle, the production per given apparatus is increased and the efficiency is 2 to 3 per cent better. With a temperature of 350-400 deg. C. of the catalyzing masses, and with a quantity of air 10 per cent less than that theoretically required, the efficiency in ketone is 94 to 96 per cent; the escaping gases are composed of quite pure nitrogen containing only very small quantities of carbon monoxide and carbon dioxide.

**Commercial Liquefaction of Gases.**—At the April 16 meeting of the Syracuse Section of the American Chemical Society, CHARLES O. BROWN, of the Semet-Solvay Co., presented a paper on "Commercial Liquefaction of Gases." An abstract of this appeared in the April, 1920, issue of the *Syracuse Chemist*, which is the official bulletin of the Syracuse Section.

A short sketch was given of the historical development of the liquefaction of gases. The evolution of the research experiments into commercial apparatus was briefly described and the change from the early cycles used to those on which present theory is based was described in a general way.

In the production of nitrogen or oxygen, air is used as the source of these gases. After removing carbon dioxide by scrubbing, the air is compressed to 500 lb. per sq.in. by some systems, while others use only 350 lb. per sq.in.

Oil and caustic spray are removed from the compressed gas by mechanically baffling the gas after compression and cooling. The compressed gas is then liquefied and the liquid gas boiled, the vapor being separated by rectification in much the same way in which alcohol is produced. In some systems the rectifying column is under full pressure of the compressed gases, while in other systems it is under only a slight pressure, the gas having been expanded to produce the desired refrigeration. This expansion may be carried out by using a needle valve or by making the gas do work while expanding in some form of engine. This second cycle is more efficient for liquefaction than the first described. One system in use in this country uses both expansion accompanied by work for the larger proportion of gas and expansion without accomplishing work to a smaller extent. It was pointed out that by designing a suitable turbine the entire quantity of gas would be expanded in various stages of the turbine, accomplishing useful work and effecting a saving in costs as run at present.

Some costs were given for producing nitrogen, varying under different conditions between 8c. and 18c. per 1,000 cu.ft.

**Monel as a Material for Internal Combustion Engine Valves.**—To secure a valve material capable of giving satisfactory service under high temperature conditions has been one of the greatest problems in the development of the present-day aviation engine. In a recent paper presented to the English Institution of Automobile Engineers, the merits of different steels for this service are very fully discussed. There is, however, no mention of monel, a material which recent tests at the Bureau of Standards indicate to be deserving of serious consideration in this regard.

Exhaust valves of this material have given satisfactory performance in a 180-hp. Hispano-Suiza engine during 130 hours of running time, when tested by the Engine Section, Bureau of Standards. During the first 90 hours, the engine was devoted to tests made primarily for the study of lubricating oils and was operated for periods of about 6 hours each, during which time it was developing between 130 and 140 h.p. at 1,800 r.p.m.

Examination of these valves at the end of 45 hours operation showed them to be badly pitted. They were ground just enough to reveal the condition of the valve seats, and these, too, were found badly pitted, although no considerable drop in power had been noted. During the next 45 hours, the horsepower was substantially the same as during the first 45, although a slight increase appeared during the first run following the replacement of the valves.

They were then subjected to 40 hours service under conditions far more severe than those encountered under normal conditions of operation. The engine was being used in a study of pre-ignition and for this purpose was operated at 1,800 r.p.m., full load, for periods of from 4 to 20 minutes. During the greater share of these runs pre-ignition was intentionally produced, resulting in extremely high engine temperatures. An evidence of these high temperatures was furnished in one instance by the fusing of the nichrome electrode of a specially prepared spark plug, the electrode's melting point being 1,500 deg. C. In spite of the severity of these tests, there was no evidence of power drop from leaky valves.

At the end of 130 hours of running time, valves and valve seats appeared to be no worse than at the end of the first 45 hours. The pitted appearance which seems to be a characteristic of this material has little effect on the gas tightness of the valve.

**Analysis of Industrial Chlorbenzenes**—Chlorbenzenes are of industrial importance not only in the manufacture of melinite, but also in the preparation of dyes. It is therefore necessary to have a practical method for their exact analysis. Raw chlorbenzene consists of a complex mixture in which predominate benzene, monochlorobenzene and paradichlorobenzene, whose boiling points are respectively 80, 130 and 172 deg. C. at normal pressure. F. BOURION has studied the problem of the analysis of the raw chlorbenzene and recommends the determination of its contents in benzene, monochlorobenzene and polychlorated benzenes (*Comptes Rendus*, April 19, 1920, pp. 933-935). He makes three fractional distillations.

The temperature limits for these three fractions are: the first between 80 and 130 deg. C., the second between 130 and 131.5 deg. C., and the third between 131.5 and 172 deg. C.

The residue of the distillation consists manifestly of polychlorated benzenes. The rectified second fraction is the pure chlorbenzene.

## Recent Chemical & Metallurgical Patents

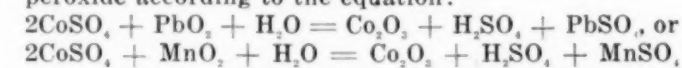
Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

**Recovery of Potassium Salts From Brines Containing Borax.**—In recovering potassium from the types of brines found in Searles Lake or Owens Lake in California, the sodium borate in the solution has offered especial difficulties in the way of separation, owing to the fact that the relative solubilities of the two salts in hot and cold solutions is substantially the same. PARKER C. MCILHINEY of Great Neck, N. Y., effects a separation of potassium from associated salts by converting the chloride into the chlorate. This can be separated in a relatively pure state. In applying the process to water from Owens Lake it is best to remove the sulphate and carbonate of sodium and the major portion of sodium chloride. This is done by evaporation, with subsequent treatment with carbon dioxide, which converts the carbonate into the relatively insoluble bicarbonate, further evaporation causing a separation of practically all the sodium salts with the exception of a small amount of the chloride. The solution, containing potassium chloride and borax, is evaporated to a concentration at 90 to 100 deg. C., which corresponds to a saturated cold solution of potassium chloride. To the hot solution is added chlorate of sodium, calcium or magnesium in proper proportion, either in hot solution or solid form. Upon cooling the solution gradually, crystals of potassium chlorate will be deposited.

It is possible to produce a soluble chlorate within the solution by treating the solution, after removal of the sulphate of sodium, with chlorine. This reacts with the sodium carbonate forming sodium chlorate which in turn reacts to form potassium chlorate. (1,338,234; April 27, 1920.)

**Purification of Zinc Solutions.**—In order to obtain a successful deposition of zinc by electrolysis of a zinc sulphate solution impurities such as copper, cadmium, arsenic, antimony, iron, cobalt and nickel must be substantially eliminated. Satisfactory methods for the removal of all of the above-mentioned impurities have been developed with the exception of nickel and cobalt, the usual procedure being to agitate the solution with zinc dust at atmospheric temperature with air, or to treat in tube mills with zinc balls. This treatment does not remove nickel and cobalt completely.

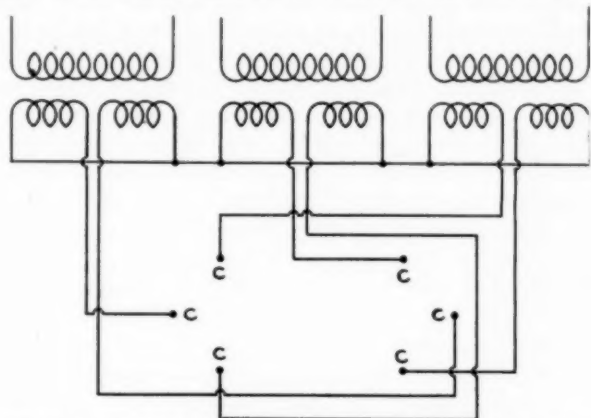
According to the present invention cobalt is removed by agitating the solution with lead peroxide or manganese dioxide. The cobalt is precipitated as the peroxide according to the equation:



The solution is heated to between 80 and 100 deg. C., one part of reagent to 200 parts solution being used. Nickel can be removed by agitating with finely divided zinc at an elevated temperature. (1,336,386; H. LIVINGSTONE SULMAN and SAMUEL FIELD of London, England; assigned to Metals Extraction Corporation, Ltd.; April 6, 1920.)



**Electric Blast Furnace.**—In the operation of electric blast furnaces using three-phase current and producing heat by the ohmic resistance between electrodes entering the charge, one difficulty experienced in practice is that although the tension between any pair of diametrically opposite electrodes is constant, the tension between any other pair varies so that the current will also vary and cause corresponding variations in the heating zones of the furnace. This irregular heating produces deleterious effects on portions of the lining and roof. Also in case of accident



TRANSFORMERS AND CONNECTIONS FOR ELECTRIC BLAST FURNACE

to one electrode or its connections the particular phase between said electrode and the other electrode associated therewith will disappear.

To overcome these disadvantages and also to produce uniform heating effect, JAMES BIBBY and JENS O. BOVING of London, England, utilize transformers and connections as shown in the accompanying sketch.

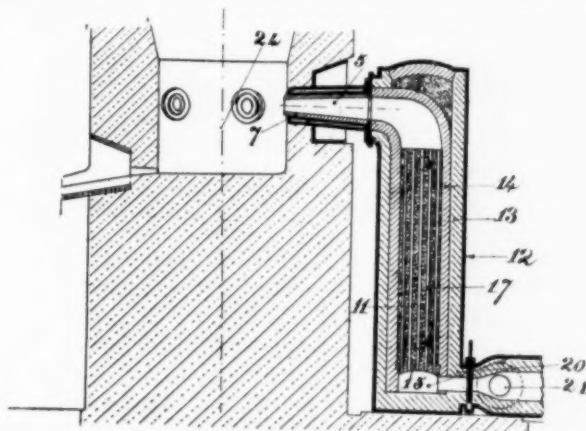
Three single-phase or a single three-phase transformer is employed and the neutral points of the three secondaries are connected together. Six electrodes *C* are employed, opposite pairs being connected to the same secondary winding. By connecting the windings in this way the several phases are anchored together, so that instead of three single independent phases there are virtually produced six phases of fixed and definite relationship. Consequently under normal conditions the heating is regular throughout the heating zones and the efficiency and life of the furnace are considerably enhanced. The disconnection of one electrode will not be as serious as when but three electrodes are employed. (1,336,017; assigned to Electro-Metals, Ltd.; April 6, 1920.)

**Electric-Resistance Alloy.**—The addition of approximately 10 per cent of titanium to an alloy consisting of 83 per cent nickel and 17 per cent chromium will produce an alloy having a specific resistance about fifty times that of copper. This alloy is durable and malleable and has a high melting point. Its specific resistance is higher than a nickel chromium alloy. (1,337,276; WILLIAM A. SCHENCH; assigned to Western Electric Co.; April 20, 1920.)

**Electrically-Heated Melting Furnace.**—Economy in metal and in furnace linings has resulted from the rotating of non-ferrous electric arc furnaces; the results obtained have become particularly apparent when melting brass or other alloys containing volatile constituents. A usual design of arc furnace is where the body of the furnace is in the form of a cylinder rotated in a horizontal axis by means of trunnions. L. C. HARVEY of Malden, England, has developed a

furnace in the form of a flask rotated on an inclined axis. The removable electrode with the electrode holder is held stationary. Instead of using an electric arc the heat may be supplied by a heating element composed of resistance material. It is feasible to melt a metal having a high melting point by means of the arc and to continue the operation when alloying metals have been added by the resistance element, both types of electrodes being interchangeable. (1,337,839; April 20, 1920.)

**Electric Resistance Furnace.**—Cyclic utilization of gas, heated by means of an electric resistance furnace, to bring about endothermic reactions such as take place in blast furnaces or in furnaces for calcining carbonates is the subject of a patent issued to JULES SIMON and PAUL FRANCOIS SARRON of Lyons, France. The crucible, tuyeres and electric-resistance furnace are shown in the sketch. The tuyeres, 5, have a refractory lining, 7, of cast quartz or carborundum to withstand a temperature of 1,800 deg. C. This lining is inserted in a water-cooled jacket, 6. The furnace for heating the gas is formed of an outer metal shell, 12, a refractory lining, 13, and a refractory lining, 14, which is a poor conductor of electricity. Within this lining and resting on the arch, 15, is a resistance element, 11, formed from a highly refractory material and graphite and capable of being strongly heated by an electric current. In this resistance element are channels, 17, through which gas can be forced under pressure, thence through the tuyere into crucible 24 of the blast furnace. The working of the furnace is similar to that of an ordinary blast furnace, but the amount of carbon introduced with the charge is only that necessary to reduce oxides and a part of the carbonic acid, since the heat required is furnished by a cyclic gas, the latter coming from recuperators through conduit 21. On passing through the furnace charge the gas is diluted with the gaseous products



ELECTRIC RESISTANCE FURNACE

of the reactions and is passed through purifying apparatus, an amount of gas constituting the cyclic gas being sucked through heat regenerators and thence forced through the electric furnace.

The principal advantages obtained by this electric furnace are: Reduction of the amount of coke used, smaller consumption of electric energy, absence of nitrogen in cyclic gas, omission of electrodes, independence of the blast furnace proper from the electric furnace, making it possible to convert an ordinary blast furnace by the substitution of special tuyeres and the addition of the electric superheater. (1,334,809; March 23, 1920.)

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## Current Events

### in the Chemical and Metallurgical Industries

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#### Dr. Frederick G. Cottrell Receives the Willard Gibbs Medal

The Chicago Section of the American Chemical Society held its annual banquet and presentation of the Willard Gibbs medal at the City Club, Friday evening, May 21. Dr. L. V. Redman, acting as chairman, in a short address introduced Dr. W. R. Whitney, who made the presentation.

Dr. Whitney did not attempt to recite the list of well-known achievements of Dr. Cottrell, nor call attention to his processes and products, but spoke rather of the high human quality of the recipient. He said that Dr. Cottrell was a pioneer who believed in opening unbeaten trails and keeping the coefficient of success to a high standard. The chemist can well appreciate the qualities of a man who believes in ideals. Dr. Cottrell has started many things which will well outgrow his own anticipation. His appointment as chief of the Bureau of Mines is gratifying to the men of the industry. In his new position we can forgive his mistakes if he keeps to his great ideals.

#### DR. COTTRELL RESPONDS

"I have been deeply affected by Dr. Whitney's talk," replied Dr. Cottrell. "We have been colleagues many years. Knowing of no fresh piece of chemistry which I could bring as a message to this meeting, and being called upon somewhat hurriedly for a subject, I wired to Chairman Redman that I would speak on 'International Scientific Relations,' which would be broad enough to cover anything I might want to say. I want to express deep appreciation of the receipt of this beautiful medal, set in a wreath of cordial friendship and hearty welcomes as it is.

"The American chemist has a big field outside of his technical work. He is getting well into the activities of correlated subjects. The fact that he has scrambled over the border line and shown a human interest in parallel subjects is a good sign for his future.

"The experience of the war has served to illustrate the importance of the scientist in international affairs. The details of the Chemical Warfare Service are too well known to require mention here. War has furnished a great stimulus to the chemical industry, but this is only a prelude to the international character of the chemist's activities. The world has been awakened to a consciousness of the necessity for international contact. We have previously been isolated, but with 4,000,000 young men who have been thrown in contact with other peoples abroad at an impressionable age a world sense of international problems has been acquired which will form a deeper and more international life in the coming generation.

"The part the chemist plays in international relations is most important in both pure and applied chemistry. The work on international atomic weights is an illustration of the pure side and that of the International Congress of the applied side. The social side is further covered in personal courtesies like those between the New York Chemists' Club and the

London and Paris Chemists' clubs. We will eventually have a chain of chemists' clubs in the international capitals of the world, which is a very inspiring thought.

"We must be sympathetic with the different views across the water, and when the American differs from them we must not arbitrarily try to reorganize European ideas. They are getting together in Europe to emulate our example of co-operation within the United States. The new industrial societies, as well as the academic chemists in Europe, are responding. There are many things to be overcome in France, such as the aloofness with which the older men view the younger in the industry.

"A central international patent office is being considered where patents after inspection may be filed in the various countries to operate under the laws of each. This will not interfere with primary patents in the country where they originated and will facilitate establishment abroad.

"The scientist can do much to help standardization throughout the world. There are many features affecting this. It is not so hard to adapt the metric system to the chemical and mining industries, where it is already used, but the civil and mechanical engineers are up against a different problem. These things should not be forced too much by legislation, but rather developed by education. Legislation should ever be confirmatory, as has been shown in the case of the last amendment to the Constitution.

"Another field for the chemist to consider is the question of raw materials. Petroleum is one of the well-known examples of this."

In conclusion Dr. Cottrell said: "Let the younger chemists have not only the technical problems to consider, but also that of public opinion, and the habit of such consideration should be acquired."

#### Industrial Research at Denver

The Denver Civic and Commercial Association has established an industrial research department in charge of Homer B. Vanderblue, former associate professor of transportation, school of commerce, Northwestern University, Chicago. The first activities of this research department will consist of a general survey of the situation with respect to surrounding territory, raw materials, transportation conditions and other industrial aspects. Investigations will also be undertaken along specific lines of industry, such as the manufacture of brass goods, metals and woolen goods.

#### Laboratory for Low Temperature Work Established

A cryogenic laboratory is to be established at once in Washington in connection with the helium work being done by the Bureau of Mines. The necessary funds for equipping the laboratory and conducting the work are being allotted to the Bureau of Mines from appropriations made to the Army and Navy Departments. The work in this new laboratory will be directed by R. B. Moore, the chief chemist of the Bureau of Mines.



### The Federated American Engineering Societies

What appeared to be a most momentous gathering in engineering annals occurred in Washington June 3 and 4, at which time accredited representatives of nearly seventy national, local, state and regional engineering and allied technical organizations met to organize a permanent federation for welfare work by and for the engineer. It is impossible to recount at length the historical setting, and perhaps unnecessary. At least, it was noted editorially in *CHEMICAL & METALLURGICAL ENGINEERING* for May 26 that past events lent color to the belief that considerable opposition might be expected to the proposed plan to organize a federation of societies rather than an association of individuals.

Upon convening, however, it appeared essential to determine this debatable and fundamental question first of all. Consequently a very sharp debate occupied several hours' session over the following resolution:

Resolved, That it is the sense of this conference that an organization be created to further the public welfare where technical knowledge and engineering experience are involved and to consider and act upon matters of common concern to the engineering and allied technical professions, and

Resolved, That it is the sense of the conference that the proper organization should be an organization of societies and affiliations and not of individuals.

Naturally, the prime opposition came from the very able representatives of the American Association of Engineers, the foremost champion of the individualistic idea. As it appeared more and more certain, however, that the convention as a whole was determined to accept the resolution, on final roll call the A.A.E. representatives, leading alphabetically, voted aye. Of the fifty-seven societies represented in this session, five answered "present," and all the rest voted aye, 119 individual unanimous ballots being cast.

Then followed a continuous session of more than twelve hours, where the details of organization were worked out in committee on constitution and bylaws. This committee reported on the morning of the second day, and not until 3 o'clock in the afternoon was the constitution adopted, essentially as reported. Many divisions were taken, however, some determined by a narrow majority of two votes. On final roll call, of the sixty-seven societies represented, ten were absent, eight answered "present," and forty-nine voted to adopt, eighty-eight unanimous individual votes being cast. In answering "present," William J. H. Strong, of the American Association of Engineers, reviewed that body's criticisms of the constitution, but assured the meeting that whether their organization eventually joined the new federation or not they at all times stood ready to co-operate in all ways possible.

The constitution having thus been adopted, the bylaws were adopted as read, subject to editorial and legal revision of phraseology. Important sections of these documents follow:

#### CONSTITUTION

##### ART. I. NAME

The name of this organization shall be the Federated American Engineering Societies.

##### ART. II. OBJECT

The object of this organization is to further the interests of the public through the use of technical knowledge and engineering experience, and to consider and act upon matters common to the engineering and allied technical professions.

#### ART. III. MEMBERSHIP

Sec. 1. The membership shall consist of national, local, state and regional engineering and allied technical organizations and affiliations, classified as follows:

(1) National engineering and allied technical organizations.

(2) Local, state or regional engineering or allied technical organizations other than local associations, sections, branches or chapters of national organizations.

(3) Affiliations consisting of any one, or a combination of the following constituents:

(a) Local sections or associations of members of national organizations included under (1).

(b) Local engineering or allied technical societies or clubs, not of national scope.

(c) Local engineers and members of allied technical professions and their associates.

#### ART. IV. MANAGEMENT

##### American Engineering Council

Sec. 1. The management of this organization shall be vested in a body to be known as the "American Engineering Council," and its Executive Board.

Sec. 2. *Functions.* The American Engineering Council shall consist of representatives of member-societies selected as hereinafter provided. This Council shall co-ordinate the activities of state councils and of local affiliations whenever these activities are of national or general importance or may affect the general interests of engineers.

Sec. 3. *Representation.* Each national, local, state or regional organization or affiliation shall be entitled to one representative on the Council for a membership of 100 to 1,000 inclusive, and one additional representative for every additional 1,000 members or major fraction thereof; provided that in the determination of the representation of local, state or regional organizations or affiliations no count shall be taken of any organization which is represented individually or through another local, state or regional organization or affiliation; and provided further that no organization shall have more than twenty representatives on the Council.

##### Executive Board

Sec. 7. *Functions.* There shall be an Executive Board of thirty members of the Council charged with conducting the business of the organization under the direction of the Council.

Sec. 8. *Membership.* The Executive Board shall consist of thirty members, of whom six shall be the officers elected by the Council and twenty-four shall be selected, a part by the national societies, and the remainder by the local, state or regional organizations or affiliations according to districts, as provided in the bylaws; provided that the number of representatives of the national societies shall bear as near as may be the same ratio to the number of representatives of local, state or regional organizations or affiliations as the representation of the national societies bears to the representation of the local, state or regional organizations or affiliations.

#### ART. VI. FUNDS

Sec. 1. Funds for the use of the organization shall be contributed as follows:

(a) Each national society represented on the American Engineering Council shall contribute annually \$1.50 per member.

(b) Each local, state or regional organization or affiliation represented on the Council shall contribute annually \$1 per member.

No portion of such funds shall be applied to the use of local affiliations or state councils.

#### ART. VII. LOCAL AFFILIATIONS

Sec. 1. *Object.* The American Engineering Council shall encourage the formation of local affiliations, to consider matters of local public welfare with which the engineering and allied technical professions are concerned, as well as other matters of common interest to these professions, in order that there may be united action and that suggestions and advice may be offered to the Council.

#### ART. VIII. STATE COUNCILS

Sec. 1. *Object.* State councils, consisting of representatives of local affiliations within the state or otherwise representative of the majority of engineers and

members of allied technical professions in the state, if members of this organization, shall consider state matters of public welfare with which the engineering and allied technical professions are concerned, as well as other matters of common interest to these professions, in order that there may be united action in state affairs.

#### ART. IX. DELIMITATION OF AUTHORITY

Local affiliations, state councils and the American Engineering Council shall deal with local, state and national matters respectively, and they shall be autonomous with respect thereto.

#### ART. X. PUBLICITY

This organization shall stand for the principle of publicity and open meetings under such regulations as may be provided for in the bylaws.

#### BYLAWS

##### CHAP. I. MEMBERSHIP.

Sec. 1. *Qualifications.* Any society or organization of the engineering or allied technical professions is eligible for membership, the chief object of which is the advancement of the knowledge and practice of engineering or the application of allied sciences, and which is not organized for commercial purposes.

##### CHAP. II. MANAGEMENT

Sec. 1. *Terms of Representatives.* Representatives on the American Engineering Council shall serve for two years; provided that after the first election, where there is more than one representative from one organization, approximately half shall be elected each year.

Sec. 3. *Votes of Representatives.* Representatives on the Council and on the Executive Board shall each have one vote on these bodies.

Sec. 6. *Duties of Officers.* The Executive Officer shall be appointed and his compensation fixed annually by the Executive Board and shall hold office during its pleasure. He shall be the Secretary of the Council and of its Executive Board. He shall manage the business of the Council under the direction of the Executive Board, and perform such duties as may be assigned to him by the Council or the Executive Board. He shall be the custodian of the property of the Council. He shall collect all moneys due the Council and transfer them to the custody of the Treasurer. He shall scrutinize all expenditures and use his best endeavors to secure economy in the administration of the business of the Council. He shall certify to the accuracy of all bills or vouchers on which money is to be paid. He shall give a bond at the expense of the Council in amount and with surety satisfactory to the Board. He shall pay the current expenses of the office and for this purpose shall have at his disposal a suitable sum of money to be fixed by the Board, which amount shall be periodically replenished under the authority of the Finance Committee upon the representation of an amount of disbursements in the form required by it. He shall mail to the member-societies bills for their annual contributions thirty days prior to the beginning of the fiscal year. He shall perform such other duties as may from time to time be assigned to him by the Council or the Executive Board.

Sec. 8. *Duties of Executive Board.* It shall hold regular monthly meetings except during July and August.

The Executive Board, unless otherwise provided, shall appoint all special committees of the Council and of the Executive Board. The membership of such committees may be drawn from the membership of the Council or of the member-societies.

The Executive Board shall, whenever practicable, provide for the whole or a part of the expenses of representatives attending meetings of the Council and of the Executive Board.

Sec. 9. *Appointment of Committees.* Committees shall be appointed from the membership of the Board annually by the incoming president with the approval of the Executive Board, each member to serve one year, or until his successor is appointed.

##### Sec. 10. *Duties of Committees:*

The Committee on Publicity and Publication shall, when so requested, prepare all public statements and shall have the direction of publications of the Council.

The Committee on Membership and Representation shall report to the Executive Board on eligibility of each applicant for membership and the number of

representatives to which it would be entitled. It shall review and report at least ninety days before each regular meeting of the Council the number of representatives to which each member-society is entitled. It shall review the existing electoral districts and report thereon to the Executive Board, at least once every two years. It shall report on all questions regarding registration and credentials of representatives on the Council.

The Finance Committee shall report an annual budget to the Executive Chairman and he or some other member of the committee shall countersign all checks for the payment of money.

The Committee on Public Affairs shall report to the Executive Board on all public affairs with which the engineer is concerned or which affect the relation of the engineer to the public.

#### CHAP. IV. PUBLICITY

Sec. 1. The privilege of attendance of all meetings of the American Engineering Council, of the Executive Board and committees, when not in executive session, shall be extended to any proper person, but this privilege does not extend the right to speak or vote. Any proper person shall have the right to inspect and make true copies of the records of all meetings of the Council, Executive Board and committees.

### Fixed Nitrogen Corporation Bill Holds Position on Senate Calendar

In order that the bill creating the United States Fixed Nitrogen Corporation might enjoy the prestige of a position on the calendar it was reported favorably to the Senate just prior to adjournment. The original bill was changed in only one particular. Where it provided for the payment of the common stock subscription of \$12,500,000 from the Treasury, the committee amended the bill as follows:

"In order to pay such subscription, as and when called, the Secretary of War is hereby authorized to sell so much as may be necessary of the supply of nitrate of soda owned by the United States and held as a reserve by the War Department, at such prices and under such regulations as may be prescribed by the Secretary of War. All sums realized from such sale are hereby appropriated to the use of the Secretary of War for the purchase of the preferred stock of the corporation."

### Savannah Section of the A. C. S. Formed

By a waiver of jurisdiction from the Georgia Section of the American Chemical Society, as required by the action of the Council of the society on April 12 at St. Louis, Mo., a charter was granted on May 10 to a new section to be known as the Savannah Section and embracing the counties of Chatham, Effingham, Bryan, Liberty, Wayne, McIntosh, Glynn and Camden, Ga.

On May 27 the section was organized and the following officers were elected to serve for the balance of the year: President, J. J. McManus; vice-president, Maurice Siegel; secretary-treasurer, Herbert P. Strack; councillor, Dr. F. N. Smalley.

Prospects are promising for a live section.

### German Dyes Imported

A shipment of German dyes consisting of 515 barrels and eight cases of assorted colors, consigned to the Textile Alliance, arrived recently on the steamer West Waunake from Antwerp. These dyes had previously been allocated to various consumers and will not be put on the open market.

Nine barrels and forty-three cylinders of Swiss dyes consigned to four concerns arrived on the same ship.



### Canadian Meeting Itinerary and Program of the American Institute of Chemical Engineers

Officially the Spring Meeting of the A. I. C. E. will open at 9 o'clock Monday morning, June 28, at the Hotel Windsor, Montreal, but a quorum of the navigators of the society will assemble beforehand on the S.S. Berkshire at Pier 32, North River, New York, sailing up the Hudson at 6 p.m. and arriving at Albany at 6 o'clock Sunday morning. The party will take the 7:20 D. & H. R.R. train to Lake George, where the S.S. Horicon will be boarded for Baldwin, which will give a delightful forenoon excursion. The S.S. Vermont will be taken at Montcalm Landing at 1:15 for Plattsburg, where the 7:15 train for Montreal will be met, giving the entire Sunday afternoon to the enjoyment of the rare beauty of the waters and shores of Lake Champlain.

Following is the program for the meeting:

#### MONDAY, JUNE 28

##### Meeting at Hotel Windsor, Montreal

9 A.M.—Business sessions, reports of Council, officers and committees.

10 A.M.—Reading of papers: address of welcome; "The Mann Report," A. W. Smith; "The Proposed National Department of Public Works," James R. Withrow; Symposium on Electrolytic Cells: "Early Commercial Electrolytic Cells," C. B. Barton; "The Fundamentals of Electrolytic Diaphragm Cells," H. K. Moore; "The Vertical Cylindrical Cell," L. D. Vorce; paper whose title has not yet been announced, A. H. Hooker.

2 P.M.—Reading of papers: "The Manufacture of Lime for Chemical and Metallurgical Purposes" (lantern slides), R. K. Meade; "The Evaporator Laboratory at the University of Michigan," W. L. Badger; "The Relation Between Temperature Drop and Heat Transmission in Vertical Tube Evaporators," W. L. Badger and P. W. Shepard; "The Re-

lation Between the Boiling Point of Saturated Sodium Chloride Solution and Pressure," W. L. Badger and E. M. Baker; "The Relation Between Hydrostatic Head and Temperature Drop in Vertical Tube Evaporators," W. L. Badger and P. W. Shepard; "Experiments on the Corrosion of Iron and Steel," W. D. Richardson; "The Solution of Metals in Acids as Related to Corrosion," W. D. Richardson; "A Suggested Basis for an Index of Corrosion of Iron and Steel," W. D. Richardson.

#### TUESDAY, JUNE 29

##### Meeting at Hotel Windsor

9 A.M.—Business sessions.

10 A.M.—Reading of papers: "Byproduct Coke Oven Industry," C. R. Bellamy; "American Progress in Dendro-Chemistry," H. O. Chute; "Industrial Application of Absorption" (illustrated by lantern slides), E. B. Miller; "The Sulphuric Acid Plant Fume Problem," J. R. Withrow and Frank C. Vilbrandt; "Chemistry of Rubber," Maximilian Toch.

2 P.M.—Visit to the glycerine refineries of Max & Rawolle, Ltd., by special street car.

8 P.M.—Meeting place to be announced. "Utilization of Peat," B. F. Haanel.

9 P.M.—Smoker at Windsor Hotel.

#### WEDNESDAY, JUNE 30

"Institute Special Train" will leave Ottawa for Belleville sufficiently early in the evening to pass through the scenic Rideau Lake District by daylight. Arrive at Belleville about 10:30 P.M. Train will be met on arrival by members of the Belleville Committee. Members who prefer to secure rooms at the Hotel Quinte should make reservations in advance to the Secretary, Dr. J. C. Olsen, or to Lucius E. Allen, Belleville, Ont.

#### THURSDAY, JULY 1

9:30 A.M.—Members will be taken for a motor drive about the city, visiting points of interest, and leave for Deloro, via Sterling and Marmora, viewing en route the Oak Hills and the Trent Valley.

11:30 A.M.—Arrive at Deloro. Inspection of the extensive works of the Deloro Smelting & Refining Co., Ltd., where the process of smelting and refining ores from the Cobalt region is carried out, producing cobalt, nickel and arsenic. Stellite metal is also produced by the electric furnace.

1 P.M.—A luncheon will be tendered all visiting members by the Deloro Smelting & Refining Co., Ltd., at its clubhouse.

2 P.M.—Leave for Belleville, via Madoc, at which point a short stop will be made at the plant of G. H. Gillespie & Co., miner and manufacturer of talc. There are also several fluorspar mines at Madoc.

4 P.M.—Inspection of the extensive plant of the Industrial Alcohol Co., Ltd., at Corbyville. This plant has been in operation since 1859 and in addition to manufacturing industrial alcohol, produces the famous "Corby Special Selected Rye Whiskey."

5:45 P.M.—Informal reception to members and their ladies at the Belleville Club. Light refreshments will be served.

7:30 P.M.—Complimentary dinner at the Hotel Quinte, tendered by the City of Belleville and the County of Hastings.

11:30 P.M.—Train for Shawinigan Falls.

#### FRIDAY, JULY 2—AT SHAWINIGAN FALLS

Visits to power house of the Shawinigan Water & Power Co.; plant of the Belgo Canadian Pulp & Paper Co., manufacturer of paper, ground wood, sulphite, etc.; plant of the Canada Carbide Co., manufacturing calcium carbide; plant of the Canadian Electro Products Co., manufacturer of acetaldehyde, paraldehyde and acetic acid. Entertainment for the ladies. Opportunity may be afforded for those who desire to stop at Grand Mere and visit the Laurentide Pulp & Paper Mill.

#### SATURDAY, JULY 3—AT LATUQUE

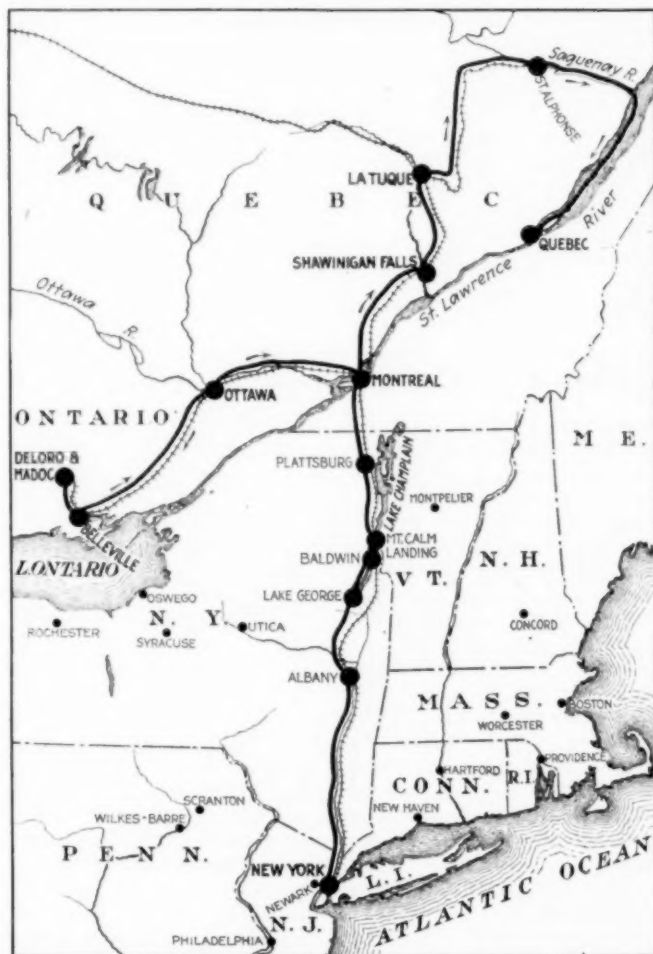
Visit to sulphate pulp mill of the Brown Co. Fishing and boating at Wayagamac Club.

#### SUNDAY, JULY 4—AT ST. ALPHONSE

All-day steamer trip down the Saguenay River to Quebec. The Saguenay trip is one of the famous trips of the world and affords a view of the beautiful scenery on this river and also on the lower St. Lawrence.

#### MONDAY, JULY 5

Visiting the beautiful and historic City of Quebec.



ITINERARY OF THE A. I. C. E.

### Gas Men Convene to Consider Crisis of Their Industry

The emergency committee and members of the American Gas Association met Wednesday, May 26, in the Hotel Pennsylvania to consider ways and means to combat the shortage of basic raw material used in the manufacture of gas. With the great scarcity of coal, coke and gas oil the situation looks discouraging for the consumers as well as the manufacturers. Some of the plants have barely enough for present operations and all are wondering whether or not they will be able to operate during the coming winter.

Philip H. Gadsden, chairman of the emergency committee, said that the most important question was "how to keep the plants functioning to the consumer." With supplies of coal practically exhausted and supply of gas oil entirely inadequate for the purpose for which it is used, due largely to the increased demands for gasoline and kerosene, a most serious and critical situation confronts the gas manufacturers.

#### RÉSUMÉ OF OIL SITUATION

N. H. C. Smith, of the Bureau of Mines, gave a résumé of the oil situation in this country, and it certainly was not very encouraging. With the tremendous demand for gasoline by the automobile industry and the development of the Diesel type of oil engine, every possible means was being used to increase the supply. Higher fractions in the distillates for motor fuel robbed the gas oil, on the one hand, while the use of fuel oil for Diesel engines and oil-burning engines robbed it on the other, thereby increasing the cost and decreasing the supply of gas oil. It is estimated that Jan. 1, 1920, there were 7,500,000 automobiles and trucks in operation in the United States and that 1,500,000 would be added this year.

Oscar H. Fogg, secretary-manager of the association, said that although the growth of the various cities was increasing steadily, the limit of growth of gas companies has been hampered because the companies had no control over their income. Under regulated rates the average price of gas in 150 cities has advanced 15 per cent in the last five years, from \$1.09 per 1,000 ft. in 1915 to \$1.26 in 1919. During the same period all other commodities, necessities and luxuries have gone well above the 100 per cent mark.

After the addresses, the following resolutions were passed:

- (1) To appoint a committee of seven to confer with representatives of the oil industry to obtain sufficient oil for the gas industry;
- (2) To establish a differential in the selling price temporarily, to meet present emergency;
- (3) To abolish the obsolete cp. standard.

### Examination for Organic and Inorganic Chemist

The United States Civil Service Commission announces that an open competitive examination for organic and inorganic chemist, for men only, will be held July 6. Vacancies in the Philippine Service at \$3,000 a year, and in positions requiring similar qualifications, at this or higher or lower salaries, will be filled from this examination, unless it is found in the interest of the service to fill any vacancy by reinstatement, transfer or promotion.

For further particulars apply to United States Civil Service Commission, Washington, D. C.

### German Dye Companies Pay Big Dividends

The balance sheets of the large aniline dye companies of Germany show that in spite of the chaotic condition of business in general they at least are making money. The report of the Farbenfabriken vorm. Fr. Bayer & Co., Leverkusen, shows a net profit (at normal rate of exchange) of \$5,725,000 as against \$3,270,000 last year.

The Farbwerke vorm. Meister Lucius & Bruning, Höchst-am-Main, has a net profit of \$6,050,000, as against \$3,750,000 last year, and a dividend of 14 per cent, as against 12 per cent last year, is being paid.

It is said that the German coal-tar ring controls 40 per cent of the capital raised last December, which carries a double voting power in order to prevent the control passing into foreign hands. The Berlin Aniline Color Works is paying 18 per cent dividends, compared with 12 per cent paid last year.

## Book Reviews

**METALLOGRAPHY. PART I—PRINCIPLES.** By Samuel L. Hoyt. New York: McGraw-Hill Book Co.; 251 pages; 1920. Price, \$3.

This is Part I of the first edition of a treatise in three parts on Metallography; namely, Part I—Principles; Part II—The Metals and Common Alloys (in press); and Part III—Technical Practice (in preparation). It is the outgrowth, says the author, of a course of lectures delivered at the University of Minnesota, and judging by its scope and treatment may best be classed as an advanced textbook on the subject. In this first general part the usual topics are covered, including chapters on constitution diagrams, preparation of metallic alloys, metallic microscopy, microstructure of metals and alloys, pyrometry and thermal analysis, physical properties and mechanical properties. Although there is nothing essentially novel in the presentation and discussion of the subject matter, the author's conventional treatment of it is due primarily to the well-established nature of its facts and hypotheses which necessarily does not permit of radical departures in this direction. The whole subject has, however, been brought quite up to date in this Part I, and the student in the field will not fail to find in it the latest authoritative information on the topics covered; he will also find the discussion more thorough and detailed than in most other textbooks of this sort.

One or two features of the book warrant special mention. The rather difficult topic of constitution diagrams has been handled in a clear and yet sufficiently comprehensive manner which should be very satisfying to the student who is not at home in the subject and would otherwise be obliged to consult other more abstract and perhaps more systematic but certainly less vivid and less easily understood treatments. Much to be commended is the author's generous use of footnote references to the best original literature; the reader will not likely get the erroneous impression that this small volume represents the confines of our knowledge on the subject, but will be stimulated to further reading and search. The illustrations are uniformly excellent and this is particularly true of the photomicrographs, which are unusually fine.

The impression is obtained that the author in the paragraphs dealing with metallographic apparatus has not always given apparatus of American manufacture the prominence which in view of its recent development it really deserves. This naturally detracts somewhat from the practical usefulness of these paragraphs.

Part I of this text certainly justifies us in awaiting the publication of the complete work with much interest and anticipation.

PAUL D. MEXICA



## Personal

H. W. DAHLBERG, of the Great Western Sugar Co., Denver, Col., is now manager of the research department, which has been combined with the statistical department.

W. C. GRAHAM, formerly manager of the research department of the Great Western Sugar Co., Denver, Col., has resigned to take entire charge of the various plants of the American Potash Co. at Antioch, Neb.

ELLWOOD HENDRICK, consulting editor of **CHEMICAL & METALLURGICAL ENGINEERING**, delivered an address before the Delaware Section of the American Chemical Society, Delaware State College, Newark, Del., on "Chemistry and Civilization," on May 29. On June 12 he will deliver the address to graduates of the Rose Polytechnic Institute, Terre Haute, Ind., at the commencement exercises.

Dr. ARTHUR LACHMAN, of San Francisco, whose mysterious disappearance last December was the cause of grave concern on the part of his friends, was found May 19 on a train en route to San Francisco and is now at his home.

W. LEE LEWIS, professor of chemistry, Northwestern University, will succeed Dr. Willard as chairman of the Chicago Section of the American Chemical Society.

Dr. GEORGE A. PERLEY, of New Hampshire College, has been at Copper Hill, Tenn.

M. J. PROFFITT, formerly of the Great Western Sugar Co., Denver, Col., is now in charge of the sugar technology division at the Bureau of Standards, Washington, D. C.

Dr. F. H. RHODES has resigned the position of director of research for the chemical department of The Barrett Co., at Frankford, Pa., in order to accept the appointment as professor of industrial chemistry in Cornell University.

Provost EDGAR SMITH of the University of Pennsylvania tendered his resignation to the board of trustees, which has been accepted. Dr. Smith presented his resignation last February. In accepting it now the board makes him emeritus professor of chemistry and places at his disposal the Harrison laboratory, where Dr. Smith expects to devote the greater part of his time to research work.

L. I. SHAW, assistant chief chemist for the U. S. Bureau of Mines, Washington, D. C., and R. T. Stull, chief ceramist for the Bureau and in charge of the station at Columbus, Ohio, have been visiting Western stations at Golden, Col., Salt Lake City, San Francisco and Seattle.

E. T. STANNARD, vice-president of the Alaska Steamship Co., has been elected a vice-president of the Kennecott Copper Corp. Mr. Stannard will move his headquarters from the mines at Kennecott to Seattle, Wash.

F. W. WILLARD, of the Western Electric Co., has transferred his activities to the planning of a new transoceanic cable plant for his company at Norfolk, Va.

C. E. WILLIAMS, who was recently assigned to electrometallurgical work at the Seattle Station of the Bureau of Mines, has reached Seattle after making a tour of the electrometallurgical centers of the East.

## Obituary

GEORGE GILBERT POND, dean of the School of Natural Science of Pennsylvania State College, died at Hartford. He was born in Holliston, in March, 1861. For five years he was instructor in chemistry at Amherst and then became a professor in the same department. He left Amherst to accept the appointment with the Pennsylvania State College.

EDMUND GYBBON SPILSBURY, mining and metallurgical engineer of note, president of the E. G. Spilsbury Engineering Co. and former president of the Engineers' Club of New York and of the American Institute of Mining and Metallurgical Engineers, died suddenly May 28 of heart failure in the New York Eye and Ear Infirmary following an operation for cataract a few days previously.

## Current Market Reports

### The Non-Ferrous Metal Market

New York, June 7, 1920.—There have been few important changes in the non-ferrous metal market. Copper declined  $\frac{3}{4}$ c., while tin strengthened slightly. Lead, also, is firmer.

	Cents per Lb.
Copper, electrolytic.....	18.50
Aluminum, 98 to 99 per cent.....	32@35
Antimony, wholesale lots.....	25
Nickel, ordinary.....	43.70
Nickel, electrolytic.....	45.00
Tin, Straits, spot.....	51.00
Lead, New York, spot.....	20@25
Lead, E. St. Louis, spot.....	8.50
Zinc, spot, New York.....	7.85
Zinc, spot, E. St. Louis.....	7.50

### OTHER METALS

Silver.....	oz.	\$0.9925
Cadmium.....	lb.	1.40@1.50
Bismuth, (500 lb. lots).....	lb.	2.70@3.00
Cobalt.....	lb.	2.30@3.00
Magnesium (f.o.b. Niagara Falls).....	lb.	1.60@1.85
Platinum.....	oz.	90@95
Iridium.....	oz.	300@400
Palladium.....	oz.	90@100
Mercury.....	75 lb.	87.50

### FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled.....	33.50
Copper bottoms.....	38.00
Copper rods.....	38.00@40.00
High brass wire and sheets.....	30.25
High brass rods.....	25.00
Low brass wire and sheets.....	27.25
Low brass rods.....	28.00
Brass tubing.....	43.25
Brass tubing.....	41.75
Seamless copper tubing.....	34.00
Seamless high brass tubing.....	33.00

### SCRAP METALS

	Cents per Lb. Buying Price
Aluminum, cast scrap.....	24.00@25.50
Aluminum, sheet scrap.....	24.00@25.50
Copper, heavy machinery comp.....	15.00@16.00
Copper, heavy and wire.....	15.50@16.00
Copper, light and bottoms.....	14.00@14.50
Copper, heavy cut and crucible.....	16.25@16.75
Brass, heavy.....	9.50@10.00
Brass, light.....	8.00@8.50
No. 1 clean brass turnings.....	9.25@9.75
No. 1 comp. turnings.....	13.50@14.00
Lead, tea.....	5.00@5.50
Lead, heavy.....	7.00@7.25
Zinc, scrap.....	5.00@5.25

### The Iron and Steel Market

Pittsburgh, Pa., June 3, 1920.

The improvement in rail traffic conditions that began two or three weeks ago is now proceeding at a more rapid pace. It is not a case of strikers returning to work, as the strike itself was practically ended some time ago, but rather of new men becoming more accustomed to their work, of team work by the railroads, under the direction of the Interstate Commerce Commission, having an effect, and of the natural tendency of a rail congestion to diminish more and more rapidly. In previous cases of traffic congestion the railroads would labor for a long time without apparent results, but when improvement once began it would proceed more and more rapidly.

There are few points now that cannot be reached by rail shipments, if the shipment can once be started. With many steel consumers the point is not to receive fresh shipments from mills, but rather to get shipments that were put on the rails long ago and stalled somewhere en route. As to car supplies, they are still meager, but practically all plants report more or less improvement in placements. Of notable assistance in improving the position of the iron and steel industry has been the partial resumption of the Pittsburgh & Lake Erie, so important to the Youngstown district. The road is still not doing a great deal in handling carload freight, but solid through freight train movement is fairly heavy. As a result largely of improvement on the Pittsburgh & Lake Erie, operations in the Youngstown district at blast furnaces at steel mills, though hardly at finishing mills, are now at about 70 per cent.

The steel industry has hardly attained the point yet of making shipments equal to its current production, but such a point does not seem to be far distant now, and when that is attained the mills must address themselves to the movement of the large amount of steel that has accumulated. Except for a moderate tonnage of ingots and billets, all the steel accumulated has been on order. What effect upon the attitude of consumers the movement of so much steel will have remains to be seen. Ever since the beginning of the rail strike it has been notable that while consumers of steel in general were incommoded, they did not seem to be incommoded as much as one would expect from the great reduction in steel receipts.

#### MARKET PROSPECTS

The pig iron, unfinished steel and finished steel markets are all very dull, the condition having become more pronounced week by week. The attitudes of buyers and sellers are just what they usually are in such a combination of circumstances. Buyers, having been very nervous earlier in the year for fear they would not secure all the steel they expected to need and having bid up prices with all the mills that were desirous of obtaining as high prices as possible, are now nervous in the other direction, and will buy nothing but what they are absolutely certain they will need. A few are even thinking about reselling stocks and material due them, in expectation that they may be able to replace the material later on, though they cannot now, at lower prices.

#### PRODUCERS INDISPOSED TO REDUCE PRICES

As usual, the producers are indisposed to reduce prices merely because their sales are lighter than formerly. As long as the steel producer has unfilled tonnage on books he is disposed to stand firm, for to cut prices to effect forward sales starts a disturbance in the market and by the time the delivery period arrives the buyer may have still better offers. Roughly speaking, the steel mills are sold ahead in inverse ratio to the prices they have been charging, the Steel Corporation farthest ahead, say seven or eight months as an average for all products, the large independents for from two to five months, and the small independents for shorter periods. Thus it is the highest priced mill that first has occasion to make its prices more attractive, but the price cut is the highest price, and the prices asked for farther forward deliveries are not necessarily affected. Black sheets for prompt shipment, for illustration, brought as high as 10c. toward the close of February and about 9c. a month ago, while now they can be had for about 7.50c. Independents that are sold up for from two to three months ahead, however, have only been quoting between 5c. and 6c. and their position is not necessarily disturbed, while the Steel Corporation, with its Industrial Board price of 4.35c., is not concerned whatever in the matter.

#### PIG IRON

The market in pig iron continues to be confined to small lots for early or spot shipment, and thus the test of values for far forward deliveries, such as are ordinarily contracted for in a strong market, is entirely lacking. Prompt bessemer recently brought \$43, valley, in small lots, as against \$42.50 formerly quoted, making "the market," such as there is, quotable at \$43, valley. Foundry continues quotable at \$45, valley. Basic, which seemed to be established at \$43.50, is reported to have sold at \$43 in one or two instances. The furnaces are well sold up for a few months, on the basis of customers taking full deliveries according to contract.

#### SEMI-FINISHED STEEL

Billets are in no request and prices are simply nominal as last done in actual transactions, \$60 to \$65 for standard billets and \$70 for small billets. Sheet bars are in light demand, makers quoting \$70 to \$75 on bessemer and \$75 to \$80 on open-hearth. There is a fair demand for slabs, with offerings light, except of blooming-mill slabs. Rods are in moderate demand, at \$70 to \$75, but not as active as two or three weeks ago.

#### FERRO-ALLOYS

The pressure for prompt ferromanganese has subsided and the market is not strong at the previous quotation of \$250, delivered. Contract alloy remains at \$200, delivered. Spiegeleisen is quiet at \$72.50@75, furnace, for prompt or forward. Electrolytic ferrosilicon is inactive, prices being largely nominal at about \$78@80 for 50 per cent and \$150@155 for 75 per cent, delivered. Bessemer ferrosilicon remains at \$62.50 for 10 per cent, \$65.80 for 11 per cent and \$69.10 for 12 per cent, f.o.b. furnaces at New Straitsville and Jackson, Ohio.

#### The Chemical and Allied Industrial Markets

New York, June 4, 1920.

There has been very little activity in the chemical market during the period, with whatever buying that has been done confined to small orders. The general impression seems to be that the transportation situation is easier and points to recovery soon, although producers are still having difficulty in obtaining raw materials for the manufacturing of the finished product. The firmness noted throughout the acid list for some time back is well sustained, while *muratic*, 20 deg., which is very scarce, has been sold as high as \$3.50@4.50 per cwt. during the week. There has been no actual change in *acetic*, 99½ per cent glacial, but the average price is now nearer \$17 than it has been for the past few weeks. *Caustic potash* is on the decline and sales have been heard of around 27c. per lb., but business on this item has been very small and producers are gradually recovering from the recent difficulties with labor and transportation. *Soda ash* remains in the same nominal position, with very little material being offered on the spot market at prices ranging between \$3.50 and \$4 per cwt. There are some resale American goods being offered by Japan at figures below the present market. These offerings are for contracts at \$3@3.50 per cwt., but buyers are not disposed to take chances on future delivery. *Caustic soda* is in practically the same position, \$6.25@6.50 per cwt. being the prevailing nominal quotations, with offerings coming in from Japan at figures slightly under this price.

#### COAL-TAR PRODUCTS

Although there have been some few declines during the period, the long expected break has not yet arrived. In general former quotations hold, with very little material changing hands, and that in a small way. Japan at present is a factor in this market and is offering material at prices below those quoted here, but consumers seem to be sitting tight watching for the long-promised upheaval in the domestic market. *Dimethylaniline* is now back on the market after a considerable absence and offerings range between \$1.25 and \$1.50 per lb., against a range of \$1.50 to \$1.60 of the previous week. *Aniline oil* dropped to a new level and is now to be had at 42@48c. per lb., compared with 45@50c., the recently prevailing figure.

#### NAVAL STORES

This market continues dull, with very small offerings being made in the *rosins*. Former prices still hold nominally, as shipping conditions from Savannah are still retarding the arrival of material in this port. *Turpentine* is now in fairly good supply and further arrivals are expected shortly. The current price in the New York market is around \$1.95 per gal., which, compared with the top figure of \$2.35 of last week's report, represents a considerable drop in this item.

#### CRUDE RUBBER

The unsettled conditions of the money market, combined with a holding back on the part of the large rubber consumers, have brought about the listless condition of this market. *Rubber* has been on a steady decline for some time past and the absence of the usual fluctuating prices, added to the fact that present spot quotations are below future offerings, emphasizes the absolute lack of activity in the trade.



## General Chemicals

## CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots	Less Carlots
Acetic anhydride.....lb.		
Acetone.....lb.	\$0.15 - \$0.20	\$0.65 - \$0.75
Acid, acetic, 28 per cent.....cwt.	3.50 - 3.75	4.00 - 4.25
Acetic, 56 per cent.....cwt.	6.00 - 6.50	8.75 - 9.00
Acetic, glacial, 99½ per cent, carboy.....lb.	15.50 - 16.00	16.50 - 18.00
Boric, crystals.....lb.	15 - 15½	15½ - 16½
Boric, powder.....lb.	15 - 15½	15 - 16
Citric.....lb.	1.15 - 1.12	1.17 - 1.18
Hydrochloric (nominal).....cwt.	2.00 - 2.50	3.50 - 4.00
Hydrofluoric, 52 per cent.....lb.	12 - 12½	13 - 14
Lactic, 44 per cent tech.....lb.	11 - 11½	12 - 16
Lactic, 22 per cent tech.....lb.	0.4 - 0.5	0.6 - 0.7
Molybdic, C. P.....lb.	4.00 - 4.50	4.50 - 5.00
Muriatic, 20 deg. (see hydrochloric).....lb.	0.6 - 0.7	0.7 - 0.8
Nitric, 40 deg.....lb.	0.7 - 0.8	0.8 - 0.9
Nitric, 42 deg.....lb.	0.7 - 0.8	0.8 - 0.9
Oxalic, crystals.....lb.	55 - 57	60 - 65
Phosphoric, Ortho, 50 per cent solution.....lb.	22 - 23	24 - 25
Picric.....lb.	28 - 35	40 - 50
Pyrogallol, resublimed.....lb.	2.50 - 2.55	2.60 - 2.65
Sulphuric, 60 deg., tank cars.....ton	14.00 - 18.00	
Sulphuric, 60 deg., drums.....ton		
Sulphuric, 66 deg., tank cars.....ton	23.00 - 25.00	50.00 - 55.00
Sulphuric, 66 deg., drums.....ton	35.00 - 40.00	50.00 - 55.00
Sulphuric, 66 deg., carboys.....ton	36.00 - 40.00	
Sulphuric, fuming, 20 per cent (oleum) tank cars.....ton	27.00 - 30.00	37.00 - 42.00
Sulphuric, fuming, 20 per cent (oleum) drums.....ton	28.00 - 30.00	38.00 - 42.00
Sulphuric, fuming, 20 per cent (oleum) carboys.....ton	32.00 - 35.00	40.00 - 45.00
Tannic, U. S. P.....lb.	1.50 - 1.60	1.65 - 1.70
Tannic (tech).....lb.		60 - 90
Tartaric, crystals.....lb.		80 - 85
Tungstic, per lb. of WO.....lb.		1.20 - 1.40
Alcohol, Ethyl (nominal).....gal.	5.10 - 5.50	6.00 - 7.00
Alcohol, Methyl, 95%.....gal.		2.50 - 2.70
Alcohol, Methyl, pure.....gal.		3.50 - 3.55
Alcohol, denatured, 188 proof (nominal).....gal.		1.10 - 1.15
Alcohol, denatured, 190 proof (nominal).....gal.		1.05 - 1.10
Alum, ammonia lump.....lb.	0.4 - 0.5	0.5 - 0.6
Alum, potash lump.....lb.	0.7 - 0.8	0.9 - 0.9
Alum, chrome lump.....lb.	1.5 - 1.8	1.9 - 2.0
Aluminum sulphate, commercial (nominal).....lb.	0.1 - 0.2	0.2 - 0.3
Aluminum sulphate, iron free.....lb.	0.2 - 0.3	0.4 - 0.4
Aqua ammonia, 26 deg., drums (750 lb.).....lb.	0.7 - 1.0	1.1 - 1.2
Ammonia, anhydrous, cylinders (100-150 lb.).....lb.	32 - 35	35 - 40
Ammonium carbonate, powder.....lb.	16 - 16½	17 - 17½
Ammonium chloride, granular (white sal-ammoniac) (nominal).....lb.	16 - 16½	17 - 18
Ammonium chloride, granular (gray sal-ammoniac).....lb.	12 - 13	13 - 14
Ammonium nitrate.....lb.	0.8 - 1.2	0.8 - 1.2
Ammonium sulphate.....lb.	0.7 - 0.7½	0.8 - 0.8½
Amylacetate.....gal.		5.00 - 5.25
Amylacetate tech.....gal.		4.75 - 5.25
Arsenic, oxide, lumps (white arsenic).....lb.		13 - 14
Arsenic, sulphide, powdered (red arsenic).....lb.	23 - 24	
Barium chloride.....ton	150.00 - 160.00	1.75 - 2.00
Barium dioxide (peroxide).....lb.	21 - 23	24 - 25
Barium nitrate.....lb.	0.9 - 1.1	1.1 - 1.2
Barium sulphate (precip.) (blanc fixe).....lb.	0.4 - 0.5	0.5 - 0.6
Bleaching powder (see calcium hypochlorite).....lb.		
Blue vitriol (see copper sulphate).....lb.		
Borax (see sodium borate).....lb.		
Brimstone (see sulphur, roll).....lb.		
Bromine.....lb.	70 - 90	1.00 - 1.05
Calcium acetate.....cwt.	3.50 - 3.55	
Calcium carbide.....lb.	0.4 - 0.4½	0.4 - 0.5
Calcium chloride, fused, lump.....ton	23.00 - 25.00	30.00 - 40.00
Calcium chloride, granulated.....lb.	0.1 - 0.1½	0.2 - 0.2½
Calcium hypochlorite (bleaching powder).....cwt.	4.00 - 4.25	4.50 - 5.50
Calcium peroxide.....lb.		1.50 - 1.70
Calcium phosphate, monobasic.....lb.		75 - 80
Calcium sulphate, pure.....lb.		25 - 30
Carbon bisulphide.....lb.	0.8 - 0.9	1.0 - 1.1
Carbon tetrachloride, drums.....lb.	11 - 11½	12 - 15
Carbonyl chloride (phosgene).....lb.		80 - 1.05
Caustic potash (see potassium hydroxide).....lb.		
Caustic soda (see sodium hydroxide).....lb.		
Chlorine, gas, liquid-cylinders (100 lb.).....lb.	0.9 - 0.9½	1.0 - 1.0½
Chloroform.....lb.	30 - 35	36 - 38
Cobalt oxide.....lb.		2.00 - 2.05
Copperas (see iron sulphate).....lb.		
Copper carbonate, green precipitate.....lb.	27 - 28	29 - 31
Copper cyanide.....lb.		65 - 70
Copper sulphate, crystals.....lb.	0.8 - 0.9	0.9 - 0.9½
Cream of tartar (see potassium bitartrate).....lb.		
Epsom salt (see magnesium sulphate).....lb.		
Ethyl Acetate Com. 85%.....gal.	1.35 -	1.40 -
Ethyl Acetate pure (acetate ether 98% to 100%).....gal.		1.75 -
Formaldehyde, 40 per cent (nominal).....lb.	36 - 40	57 - 65
Fusel oil, ref.....gal.		5.25 - 6.00
Fusel oil, crude (nominal).....gal.		
Glauber's salt (see sodium sulphate).....lb.		
Glycerine.....lb.		26 - 28
Iodine, resublimed.....lb.	4.30 - 4.35	4.40 - 4.45
Iron oxide, red.....lb.		0.3 - 0.20
Iron sulphate (copperas).....cwt.	1.50 - 1.75	1.80 - 2.00
Lead acetate, normal.....lb.		13 - 15
Lead arsenate (paste).....lb.	11 - 12	13 - 17
Lead nitrate, crystals.....lb.		90 - 1.00
Litharge.....lb.	14 - 15	15 - 16
Lithium carbonate.....lb.		1.50 -
Magnesium carbonate, technical.....lb.	12 - 14	15 - 16
Magnesium sulphate, U. S. P.....100 lb.	3.00 - 3.55	4.00 - 4.50
Magnesium sulphate, commercial.....100 lb.		3.25 - 3.60
Nickel salt, double.....lb.		14 - 16
Nickel salt, single.....lb.		16 - 18
Phosgene (see carbonyl chloride).....lb.		
Phosphorus, red.....lb.	50 - 55	60 - 65
Phosphorus, yellow.....lb.		35 - 37
Potassium bichromate.....lb.	35 - 37	45 - 46
Potassium bitartrate (cream of Tartar).....lb.	52 - 56	57 - 58
Potassium bromide, granular.....lb.	80 - 85	90 - 95
Potassium carbonate, U. S. P.....lb.		85 - 88
Potassium carbonate, crude.....lb.	21 - 25	26 - 28

	Carlots	Less Carlots
Potassium chlorate, crystals.....lb.	\$0.15 - \$0.16	\$0.21 -
Potassium hydroxide (caustic potash).....lb.	28 - 29	31 - 35
Potassium iodide.....lb.		3.35 - 3.60
Potassium nitrate.....lb.	15 - 17	19 - 21
Potassium permanganate.....lb.	75 - 80	85 - 95
Potassium prussiate, red.....lb.	90 - 1.00	1.05 -
Potassium prussiate, yellow.....lb.	32 - 36	36½ - 37½
Potassium sulphate (powdered).....ton	\$225.00 - 240.00	
Rochelle salts (see sodium potas. tartrate).....lb.		
Sal ammoniac (see ammonium chloride).....lb.		
Salt soda (see sodium carbonate).....ton	28.00 - 32.00	
Salt cake.....ton		
Silver cyanide (nominal).....oz.		1.25 -
Silver nitrate (nominal).....oz.		74 - 76
Soda ash, light.....100 lb.		3.50 - 3.60
Soda ash, dense.....100 lb.		3.55 - 3.65
Sodium acetate.....lb.	0.8 - 0.9	0.9 - 1.2
Sodium bicarbonate.....100 lb.	2.25 - 2.60	2.75 - 3.50
Sodium bichromate.....lb.	32 - 35	36 - 37
Sodium bisulphate (nitre cake).....ton	7.00 - 7.50	8.00 - 10.00
Sodium bisulphate Powdered.....lb.	0.6 - 0.6½	0.7 - 1.0
Sodium borate (borax).....lb.	0.9 - 1.0	1.1 - 1.2
Sodium carbonate (sal soda).....100 lb.	1.60 - 1.80	1.80 - 2.00
Sodium chloride.....lb.		10 - 11
Sodium cyanide, 96-98 per cent.....lb.	24 - 25	26 - 27
Sodium fluoride.....lb.	18 -	19 - 20
Sodium hydroxide (caustic soda).....100 lb.	4.25 - 6.00	6.25 - 6.50
Sodium hyposulphate.....lb.		0.3 - 0.4
Sodium molybdate.....lb.	2.50 -	3.25 -
Sodium nitrate.....100 lb.	3.00 - 3.25	3.75 - 4.00
Sodium nitrite.....lb.	19 - 19½	20 - 21
Sodium peroxide, powdered.....lb.	32 - 35	35 - 40
Sodium phosphate, dibasic.....lb.	0.3 - 0.4	0.4 - 0.5
Sodium potassium tartrate (Rochelle salts).....lb.		39 - 40
Sodium prussiate, yellow.....lb.	23 - 27	31 - 32
Sodium silicate, solution (40 deg.).....lb.	0.12 - 0.2	0.2 - 0.2½
Sodium silicate, solution (60 deg.).....lb.	0.2 - 0.3	0.4 - 0.5
Sodium sulphate, crystals (Glauber's salt).....cwt.	1.60 - 1.70	1.75 - 2.00
Sodium sulphide, crystal, 60-62 per cent (conc).....lb.	0.9 - 1.0	1.0 - 1.1
Sodium sulphite, crystals.....lb.	0.3 - 0.4	0.4 - 0.6
Strontium nitrate, crystals.....lb.	20 - 21	25 - 26
Sulphur chloride.....lb.	0.5 -	0.6 -
Sulphur, crude.....ton	22.00 -	
Sulphur dioxide, liquid, cylinders.....lb.	0.9 -	1.0 - 1.2
Sulphur (sublimed), flour.....100 lb.	3.35 -	3.40 - 3.65
Sulphur, roll (brimstone).....100 lb.	3.20 -	3.30 - 3.40
Tin bichloride (stannous).....lb.	42 -	46 - 50
Tin oxide.....lb.	60 - 63	65 -
Zinc carbonate, precipitate.....lb.	16 - 18	19 - 20
Zinc chloride, gran.....lb.	13 -	13½ - 17
Zinc evanide.....lb.	49 -	50 - 60
Zinc dust.....lb.	12 -	13 - 15
Zinc oxide, U. S. P.....lb.	18 - 19	20 - 21
Zinc sulphate.....lb.	0.3 - 0.3½	0.4 - 0.6

## Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha naphthol, crude.....lb.		\$1.25
Alpha naphthol, refined.....lb.		1.45
Alpha naphthylamine.....lb.	65 -	70
Aniline oil, drums extra.....lb.	35 -	40
Aniline salts.....lb.	42 -	50
Anthracene, 80% in drums (100 lb.).....lb.	90 -	1.00
Benzaldehyde (f.f.c.).....lb.	2.00 -	2.10
Benzidine, base.....lb.	1.35 -	1.40
Benzidine, sulphate.....lb.	1.20 -	1.25
Benzoic acid, U. S. P.....lb.	90 -	1.10
Benzoate of soda, U. S. P.....lb.	80 -	1.00
Benzol, pure, water-white, in drums (100 lb.).....gal.	27 -	36
Benzol, 90% in drums (100 lb.).....gal.	25 -	31
Benzyl chloride, 95-97% refined.....lb.	35 -	40
Benzyl chloride, tech.....lb.	25 -	35
Beta naphthol benzoate (nominal).....lb.	50 -	60
Beta naphthol, sublimed (nominal).....lb.	80 -	90
Beta naphthol, tech (nominal).....lb.	65 -	85
Beta naphthylamine, sublimed.....lb.	2.25 -	2.40
Cresol, U. S. P., in drums (100 lb.).....lb.	18 -	19
Ortho-cresol, in drums (100 lb.).....lb.	23 -	25
Cresylic acid, 97-99%, straw color, in drums.....gal.	1.10 -	1.20
Cresylic acid, 95-97%, dark, in drums.....gal.	1.00 -	1.05
Cresylic acid, 50%, first quality, drums.....gal.	65 -	75
Dichlorobenzol.....lb.	0.8 -	1.0
Diethylaniline.....lb.		1.80
Dimethylaniline.....lb.	1.25 -	1.50
Dinitrobenzol.....lb.	30 -	37
Dinitrochlorobenzol.....lb.	30 -	35
Dinitronaphthalene.....lb.	45 -	55
Dinitrophenol.....lb.	40 -	45
Dinitrotoluenol.....lb.	40 -	45
Dip oil, 25% tar acids, car lots, in drums.....gal.	38 -	40
Diphenylamine (nominal).....lb.		85
H-acid (nominal).....lb.	2.25 -	2.50
Metaphenylenediamine.....lb.	1.15 -	1.30
Monochlorobenzol.....lb.	12 -	15
Monoethylaniline.....lb.	1.70 -	1.85
Naphthalene crushed, in bbls. (250 lb.).....lb.	15 -	
Naphthalene, flake.....lb.	15½ -	17
Naphthalene, balls.....lb.	16 -	18
Naphthionic acid, crude.....lb.	75 -	85
Nitrobenzol.....lb.	14 -	19
Nitro-naphthalene.....lb.	40 -	50
Nitro-toluenol.....lb.	20 -	30
Ortho-amidophenol.....lb.	3.25 -	4.25
Ortho-dichlor-benzol.....lb.	15 -	20
Ortho-nitro-phenol.....lb.	80 -	1.25
Ortho-nitro-toluenol.....lb.	25 -	40
Ortho-toluidine.....lb.	35 -	45
Para-amidophenol, base.....lb.	2.50 -	3.50
Para-amidophenol, HCl.....lb.	2.50 -	3.25
Para-dichlor-benzol.....lb.	0.8 -	1.2
Paranitraniline.....lb.		1.65
Para-nitro-toluenol.....lb.	1.35 -	1.50
Paraphenylenediamine.....lb.	2.60 -	3.00
Paratoluidine.....lb.	2.00 -	2.50
Phthalic anhydride.....lb.	65 -	75
Phenol, U. S. P., drums (dest.), (240 lb.).....lb.	12 -	20
Pyridin.....gal.	2.00 -	3.50
Resorcin, technical.....lb.	4.25 -	4.50
Resorcin, pure.....lb.	6.25 -	6.75

Salicylic acid, tech., in bbls. (110 lb.)	lb.	\$0.50	—	\$0.52
Salicylic acid, U. S. P.	lb.	.50	—	.60
Salol	lb.	.90	—	1.00
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.25	—	.31
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.19	—	.24
Sulphanilic acid, crude	lb.	.28	—	.32
Toluidine	lb.	1.70	—	2.50
Toluidine, mixed	lb.	.45	—	.55
Toluol, in tank cars	gal.	.28	—	.32
Toluol, in drums	gal.	.29	—	.32
Xylidine, drums, 100 gal.	lb.	.44	—	.50
Xylol, pure, in drums	gal.	.37	—	.45
Xylol, pure, in tank cars	gal.	.35	—	.45
Xylol, commercial, in drums, 100 gal.	gal.	.37	—	.45
Xylol, commercial, in tank cars	gal.	.23	—	.27

### Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark	lb.	\$0.36	—	\$0.39
Beeswax, refined, light	lb.	.39	—	.40
Beeswax, white pure	lb.	.63	—	.68
Carnauba, No. 1 (nominal)	lb.	1.00	—	1.05
Carnauba, No. 2, regular (nominal)	lb.	.85	—	.88
Carnauba, No. 3, North Country (nominal)	lb.	.44	—	.45
Japan	lb.	.21	—	.22
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.09	—	.10
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.11	—	.12
Paraffine waxes, refined, 118-120 m.p.	lb.	.13	—	.14
Paraffine waxes, refined, 128-130 m.p.	lb.	.15	—	.16
Paraffine waxes, refined, 133-135 m.p.	lb.	.17	—	.18
Paraffine waxes, refined, 135-137 m.p.	lb.	.25	—	.26
Stearic acid, single pressed	lb.	.26	—	.27
Stearic acid, double pressed	lb.	.28	—	.29
Stearic acid, triple pressed	lb.	.28	—	.29

NOTE—Quotations on paraffine waxes are nominal.

### Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp. gr. 0.930-0.940	gal.	\$1.75	—	1.60
Pine oil, pure, dest. dist.	gal.	.48	—	.35
Pine tar oil, ref., sp. gr. 1.025-1.035	gal.	.85	—	.85
Pine tar oil, crude, sp. gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.36	—	.36
Pine tar oil, double ref., sp. gr. 0.965-0.990	gal.	1.75	—	1.75
Pine tar, ref., thin, sp. gr. 1.080-1.060	gal.	.35	—	.35
Turpentine, crude, sp. gr. 0.900-0.970	gal.	.52	—	.52
Hardwood oil, f.o.b. Mich., sp. gr. 0.960-0.990	gal.		—	
Pinewood creosote, ref.	gal.		—	

### Naval Stores

The following prices are f.o.b., New York, for carload lots.

Rosin B-D, bbl.	280 lb.	\$19.00	—	\$20.30
Rosin E-F	280 lb.	20.30	—	20.50
Rosin K-N	280 lb.	20.50	—	22.00
Rosin W-G-W-W	280 lb.	22.50	—	23.00
Wood rosin, bbl.	280 lb.	17.80	—	18.50
Spirits of turpentine	gal.	1.90	—	1.95
Wood turpentine, steam dist.	gal.	1.90	—	2.00
Wood turpentine, dest. dist.	gal.	1.90	—	2.00
Pine tar pitch, bbl.	200 lb.	14.50	—	15.00
Tar, kiln burned, bbl. (500 lb.)	500 lb.	15.00	—	15.50
Retort tar, bbl.	500 lb.	.87	—	.89
Rosin oil, first run	gal.	.89	—	.92
Rosin oil, second run	gal.	1.04	—	1.05
Rosin oil, third run	gal.	1.12	—	1.15
Rosin oil, fourth run	gal.		—	

### Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	\$0.40	—	
70-72 deg., steel bbls. (85 lb.)	gal.	.38	—	
68-70 deg., steel bbls. (85 lb.)	gal.	.37	—	
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.29	—	

### Crude Rubber

Para-Upriver fine	lb.	\$0.37	—	\$0.38
Upriver coarse	lb.	.28	—	.29
Upriver caucho ball	lb.	.30	—	.30
Plantation—First latex crepe	lb.	.38	—	.39
Ribbed smoked sheets	lb.	.38	—	.39
Brown crepe, thin, clean	lb.	.37	—	.38
Amber crepe No. 1	lb.		—	.40

### Oils

#### VEGETABLE

The following prices are f.o.b., New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	\$0.18	—	\$0.20
Castor oil, AA, in bbls.	lb.	.20	—	.22
China wood oil, in bbls.	lb.	.22	—	.23
Cocanut oil, Ceylon grade, in bbls.	lb.	.17	—	.18
Cocanut oil, Cochon grade, in bbls (nominal)	lb.	.18	—	.19
Corn oil, crude, in bbls.	lb.	.17	—	.18
Cottonseed oil, crude (f.o.b. mill)	lb.	.15	—	.16
Cottonseed oil, summer yellow	lb.	.19	—	.19
Cottonseed oil, winter yellow	lb.	.21	—	.22
Linseed oil, raw, car lots (domestic)	gal.	1.65	—	
Linseed oil, raw, tank cars (domestic)	gal.	1.60	—	
Linseed oil, boiled, car lots (domestic)	gal.	1.67	—	
Olive oil, commercial	gal.	3.10	—	3.25
Palm, Lagos	lb.	.12	—	.13
Palm, bright red	lb.	.13	—	.13
Palm, Niger	lb.	.11	—	.12
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.16	—	.17
Peanut oil, refined, in bbls.	lb.	.22	—	.24
Rapeseed oil, refined in bbls.	gal.	1.70	—	1.72
Rapeseed oil, blown, in bbls.	gal.	1.80	—	1.85
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.17	—	.18
Soya bean oil, tank cars, f.o.b. Pacific coast	lb.	.13	—	.13

#### FISH

Winter pressed Menhaden	gal.	\$1.17	—	\$1.18
Yellow bleached Menhaden	gal.	1.20	—	1.22
White bleached Menhaden	gal.	1.23	—	1.24
Blown Menhaden	gal.	1.30	—	1.32

### Miscellaneous Materials

All f. o. b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	\$20.00	—	\$22.00
Barytes, ground, off color, f.o.b. Kings Creek	net ton	16.00	—	18.00
Barytes, crude, 88% @ 94% ba., Kings Creek	net ton	8.00	—	10.00
Blanc fixe, dry	lb.	.05	—	.06
Blanc fixe, pulp	ton	60.00	—	80.00
Casein	lb.	.15	—	.18
Chalk, English, extra light	lb.	.05	—	.07
Chalk, English, light	lb.	.05	—	.06
Chalk, English, dense	lb.	.04	—	.05
China clay (Kaolin) crude, f.o.b. Pkin, Va.	net ton	8.00	—	12.00
China clay (Kaolin), imported, lump	ton	25.00	—	35.00
China clay (Kaolin), imported, powdered	ton	30.00	—	60.00
Feldspar (nominal) f.o.b. N. Y. State	ton	13.50	—	18.30
Feldspar, crude, f.o.b. Maryland and North Carolina, points	net ton	7.50	—	8.00
Feldspar, ground, f.o.b. Baltimore	net ton	18.00	—	25.00
Fire clay, f.o.b. Baltimore	net ton	5.00	—	7.00
Fuller's earth, domestic, powdered	ton	25.00	—	30.00
Fuller's earth, imported, powdered	ton	35.00	—	40.00
Graphite (dust polish grade 30%) Ashland, Ala.	lb.		—	0.01
Graphite (dust facing grade 50%) Ashland, Ala.	lb.		—	0.01
Graphite, crucible, 85% carbon Ashland, Ala.	lb.		—	.07
Graphite, crucible, 90% carbon Ashland, Ala.	lb.		—	.08
Pumice stone, imported	lb.	.03	—	.06
Pumice stone, domestic	lb.	.02	—	
Quartz (acid tower) fist to head, f.o.b. Baltimore	net ton		—	10.00
Quartz (acid tower) 1 1/2 in., f.o.b. Baltimore	net ton		—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore	net ton		—	17.00
Shellac, orange, fine	nominal	lb.	1.50	—
Shellac, orange, superfine	lb.	1.60	—	1.65
Shellac, A. C. garnet	lb.	1.30	—	1.35
Soapstone	ton	15.00	—	25.00
Talc, domestic	ton	20.00	—	60.00
Silica, imported	ton	60.00	—	70.00

### Refractories

Following prices are f.o.b. Works:

Chrome brick	net ton	\$75-80	at Chester, Penn.
Chrome cement	net ton	45-50	at Chester, Penn.
Clay brick, 1st quality fireclay	1,000	45-50	at Clearfield, Penn.
Clay brick, 2nd quality	1,000	40-45	at Clearfield, Penn.
Magnesite, dead burned	net ton	50-55	at Chester, Penn.
Magnesite brick, 9 x 4 1/2 x 2 1/2 in.	net ton	85-90	at Chester, Penn.
Silica brick	1,000	50-55	at Mt. Union, Penn.

### Ferro-Alloys

All Prices f.o.b. Works

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	\$200.00	—	\$250.00
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon	lb.	.20	—	.21
Ferro-chrome, per lb. of Cr. contained, 2-4% carbon	lb.	.21	—	.22
Ferro-manganese, 70-80% Mn	gross ton	200.00	—	250.00
Spiegeleisen, 16-20% Mn	gross ton	73.00	—	75.00
Ferro-molybdenum, per lb. of Mo	lb.	2.25	—	2.75
Ferro-silicon, 50%	gross ton	80.00	—	90.00
Ferro-silicon, 75%	gross ton	150.00	—	200.00
Ferro-silicon, 10-15%	gross ton	60.00	—	65.00
Ferro-tungsten, 70-80%, per lb. of contained W	lb.	.90	—	1.10
Ferro-uranium, 35-50%, of U	lb.	7.00	—	
Ferro-vanadium, 30-40% per lb. of contained V	lb.	6.50	—	7.75

### Ores and Semi-finished Products

All Prices f. o. b. Mines

Chrome ore, 35-40%, C <sub>2</sub> , O <sub>3</sub> f.o.b. Atlantic Seaboard	unit	\$0.70	—	\$0.85
Coke, foundry, f.o.b. ovens	net ton	15.50	—	16.50
Coke, furnace, f.o.b. ovens	net ton	14.50	—	15.50
Petroleum coke, refinery, Atlantic seaboard	net ton		—	24.00
Fluor spar, gravel, f.o.b. mines	net ton	25.00	—	30.00
*Fluor spar, acid grade, lump, f.o.b. Tonuco, Mex.	net ton	30.00	—	45.00
*Fluor spar, acid grade, ground, f.o.b. Tonuco	net ton	55.00	—	65.00
Manganese ore, 45% Mn and over	unit	.80	—	.95
Manganese ore, chemical (MnO <sub>2</sub> )	gross ton	80.00	—	90.00
Molybdenite, 85% MoS <sub>2</sub> , per lb. of MoS <sub>2</sub>	lb.	.75	—	.85
Tungsten, Scheelite, 60% WO <sub>3</sub> and over, per unit of WO <sub>3</sub>	unit	7.00	—	10.00
Tungsten, Wolframite, 60% WO <sub>3</sub> and over, per unit of WO <sub>3</sub>	unit	6.50	—	7.50
Uranium oxide, 96%	lb.	2.75	—	3.00
Vanadium pentoxide, 99%	lb.	12.00	—	14.00
Vanadium Ore	lb.	1.00	—	3.00
Pyrites, foreign, lump	unit	.17	—	
Pyrites, foreign, fine	unit	.17	—	
Pyrites, domestic, fine	unit	.16	—	.17
Ilmenite, 52% TiO <sub>2</sub>	lb.	.01	—	.02
Rutile, 95% TiO <sub>2</sub>	lb.	.15	—	.25
Carnotite, minimum 2% U <sub>3</sub> O <sub>8</sub> , per lb. of U <sub>3</sub> O <sub>8</sub>	lb.	2.75	—	3.00
Zircon, washed, iron free	lb.	.10	—	
Monazite, per unit of ThO <sub>2</sub>	unit	42.00	—	

\*Nominal.

### Structural Steel

Mill, Pittsburgh

Beams and channels, 3 to 15-in	100 lb.	\$2.45	@	\$4.00
Angles, 3 to 6-in., 1-in. thick	100 lb.	2.45	@	4.00
Tees, 3-in. and larger	100 lb.	2.45	@	4.00
Plates	100 lb.	2.65	@	4.00
Rivets, structural, 1-in. and larger	100 lb.	4.50	—	
Rivets, conehead for boilers, 1-in. and larger	100 lb.	4.60	—	
Sheets, No. 28 black	100 lb.	4.35	@	6.50
Sheets, No. 10 blue annealed	100 lb.	3.55	@	6.00
Sheets, No. 28 galvanized	100 lb.	5.70	@	8.50

For painted corrugated sheets, add 30c. per 100 lb. for 25 to 28 gage; 25c. for 19 to 24 gage; for galvanized corrugated sheets, add 15c., all gages.



# Industrial

Financial, Construction and Manufacturers' News

## Construction and Operation

### Arizona

PHOENIX—V. A. Thompson, city mgr., will receive bids until June 16 for the installation of a complete infiltration intake system.

### California

BISHOP—The Bishop Union High School Dist. received bids for the construction of a 2-story high school from R. W. Moller, Call-Post Bldg., San Francisco, \$150,846; Young & Nunemaker, Bishop, \$151,800. Laboratory equipment will be installed in same.

BURBANK—The Burbank Development Co., 206 West San Fernando St., is having plans prepared for the construction of 2 soap factory buildings on Verdugo Ave. Soap-making machinery will be installed in same. Estimated cost, \$200,000.

LONG BEACH—The city received bids for the construction of a sewage pumping plant with pumps, motors, flush tanks, etc., from John Cummings, 1200 Washington Bldg., Los Angeles, \$44,650; John Radick, \$46,999; Peter Tomick, \$57,900. A. DeRuiz, engr.

LOS ANGELES—The Miller Rubber Co., South High St., Akron, O., plans to build a tire factory to have a daily output of 2,800 casings here. F. C. Millhoff, general sales mgr.

LOS ANGELES—The Oil Mining Equipment Co., 2026 Santa Fe Ave., will build a group of factory buildings including an 80x547-ft. main building with a 60x150-ft. shed, 20x200-ft. boiler house, etc. Work will be done by day labor.

NATIONAL CITY—The city received bids for the construction of a complete sewer system, including 8 flush tanks, 73 lamp holes and septic tank, from R. H. Downer, 668 Colusa Ave., Berkeley, \$94,250; John Engbretsen, 205 McNeece Bldg., San Diego, \$110,250; M. McGinnis, San Diego, \$116,685.

SAN DIEGO—The Citrus Soap Co., 902 K St., has awarded the contract for the construction of a 4-story, 200x300-ft. soap factory at Union and Market Sts., to the Winter Constr. Co., 2141 Sacramento St., Los Angeles, at \$200,000. Noted May 26.

### Connecticut

WALLINGFORD—The Interstate Silver Co., 48 State St., Meriden, has awarded the contract for altering the factory and constructing an addition to the boiler house at Plant E, on Center St., to the Immick Co., State St., Meriden. Estimated cost, \$250,000.

### District of Columbia

WASHINGTON—The General Purchasing Officer of the Panama Canal will receive bids until June 18 for furnishing steel or pig iron, antimony, pig lead, phosphor-tin, silica sand and bituminous enamel, etc.

### Illinois

ALTON—The Illinois Glass Co. is having plans prepared for the construction of a glass plant. R. S. Godard, constr. engr.

SANDWICH—The School Bd. will soon award the contract for the construction of a 3-story high school. A chemical laboratory will be installed in same. Estimated cost, \$285,000. J. W. Royer, archt.

### Indiana

EVANSVILLE—The Indiana Atomized Fuel Co. is building a 1-story, 80x100-ft. plant to reduce coal to an atomized state by means of a chemical process. Estimated cost, from \$125,000 to \$150,000. B. U. Cain, secy.

### Iowa

AURELIA—The Consolidated School Bd. has awarded the general contract for the construction of a 4-story, 80x100-ft.

school, to W. J. Zitterell Co., Webster City. Laboratory equipment will be installed in same. Estimated cost, \$207,000.

GEORGE—The School Bd. will soon award the contract for the construction of a 2-story, 80x127-ft. high school, here. A chemical laboratory will be installed in same. Estimated cost, \$90,000. Perkins & McWayne, Sioux Falls, S. D., archts. and engr.

GREENE—F. L. Stober, Secy. of the School Bd., has awarded the contract for the construction of a 2-story, 66x127-ft. city high school, to the Miller Constr. Co., 502 Black Hawk Bank Bldg., Waterloo. A general chemical laboratory will be installed in same. Estimated cost, \$150,000.

ORIENT—J. F. Kingerly, Secy. of the Bd. Educ., is having preliminary plans prepared for the construction of a school building. A chemical laboratory will be installed in same. W. Gordon, 319 Hubbell Bldg., Des Moines, archt.

WINFIELD—The city has awarded the contract for the construction of a sewage disposal plant, to the Layton Constr. Co., Muscatine, at \$135,000.

### Maine

MADISON—The town is having plans prepared for the construction of a 2-story, 82x149-ft. high school here. A chemical laboratory will be installed in same. Harry S. Coombs, Masonic Temple, Lewiston, archt.

### Massachusetts

HUDSON—H. M. Hope Engr. Co., archts. and engr., 185 Devonshire St., Boston, will soon award the contract for the construction of a 5-story, 60x100-ft. factory for the manufacture of rubber goods, for the Apsley Rubber Co., Hudson. Estimated cost, \$125,000.

### Michigan

ASHLEY—The Bd. Educ. plans to build a 2-story high school. Chemical laboratory equipment will be installed in same. Estimated cost, \$200,000. Mrs. M. E. Green, secy. E. M. Wood, 516 Oakland Bldg., Lansing, archt.

DETROIT—Smith, Hinchman & Grylls, archts., Washington Arcade, will soon award the contract for the construction of a 1-story, 79x532-ft. factory addition on Artillery Ave., for the International Metal Stamping Co., Artillery Ave.

PONTIAC—The city has awarded the contract for the water filtration plant, to the Dreher Constr. Co., Flint. Estimated cost, \$315,399. Noted April 21.

### Minnesota

COLERAINE—A. King, clk., will receive bids until July 15 for the construction of a 2-story, 200x200-ft. high school, for the Bd. Educ. A chemical laboratory will be installed in same. Estimated cost, \$350,000. W. T. Bray, 616 Torrey Bldg., Duluth, archt. and engr.

LEWISTON—The Bd. Educ. is having plans prepared for the construction of a 3-story, 60x100-ft. addition to the high and grade school. A chemical laboratory will be installed in same. Estimated cost, \$125,000. Croft & Boerner, Palace Bldg., Minneapolis, archts.

WAYZATA—The School Bd. will soon award the contract for the construction of a 3-story, 140x150-ft. high school. A chemical laboratory will be installed in same. Estimated cost, \$325,000.

### Missouri

PILOT GROVE—The School Bd. plans to build a 2-story, 50x70-ft. high school here. A chemical laboratory will be installed in same. Estimated cost, \$35,000. H. R. Primmer, Nevada, Mo., archt.

ST. LOUIS—The St. Louis Mill Casting Co., 7701 North Conduit St., has awarded the contract for the construction of a 1-story, 100x464-ft. foundry at 347-411 Thatcher St., to the Fruln-Colnon Constr. Co., Merchants Laclede Bldg. Estimated cost, \$120,000.

### New Jersey

JERSEY CITY—Colgate & Co., 105 Hudson St., has awarded the contract for the construction of a 4-story, 45x50-ft. factory on Morris St., to E. C. Brown Co., 70 East 45th St., New York City. Estimated cost, \$70,000.

KEYPORT—The Whitall Tatum Co., 46 Barclay St., New York City, has awarded the contract for the construction of a 3-story, 50x200-ft. factory for the manufacture of glassware to H. H. Vought, Grand Central Terminal, New York City. Estimated cost, \$100,000.

NEWARK—Samuel Jones & Co., 37 McClellan St., has awarded the contract for the construction of a 1-story, 30x80-ft. factory addition, etc., to the C. R. Heddon Co., 763 Broad St., at \$25,000.

TRENTON—The Bergounan Rubber Corp. has awarded the contract for the construction of three factory buildings on Whitehead Rd., to the Farrall Constr. Co., 53 West 39th St., New York City. Estimated cost, \$250,000.

TRENTON—The Van Pottery Co., Parker Ave., has awarded the contract for the construction of a 1-story, 50x60-ft. pottery on Parker Ave., to J. P. Drugan, 134 West State St., at \$18,000.

VINELAND—F. H. Bent, engr., 142 West State St., has awarded the contract for the construction of a sewerage system including a septic tank, etc., at the Home for the Feeble Minded, to the New York Sewage Co., 39 East 28th St., New York City, at \$13,578. Noted May 19.

### New York

NEW YORK—W. Zinsser, West 59th St., has awarded the contract for the construction of a 4-story, 50x50-ft. factory for the manufacture of paint, to Ruggles-Robinson, 331 Madison Ave. Estimated cost, \$50,000. Noted May 26.

### Ohio

CLEVELAND—The Willard Storage Battery Co., 246 East 131st St., had plans prepared for the construction of a 1-story, 25x260-ft. sheet metal factory.

PROSPECT—The Bd. Educ. plans to build a 2-story high school. A chemical laboratory will be installed in same. Estimated cost, \$75,000. O. H. Howard, 8 East Broad St., Columbus, archt.

WHITEMORE—St. Michael's Roman Catholic Church plans to build a school. A chemical laboratory will be installed in same. Estimated cost, \$100,000. Address Danion & O'Meara, Mason Bldg., Ft. Dodge, Ia.

### Pennsylvania

FRANKFORD JUNCTION (Philadelphia P. O.)—The Belmont Packing & Rubber Co., 133 North 2nd St., Philadelphia, has awarded the contract for the construction of a 2-story, 120x120-ft. factory, to the Hogg Constr. Co., Denchla Bldg., Philadelphia.

### South Dakota

ARLINGTON—The Bd. Educ. is having plans prepared for the construction of a 2-story, L-shaped grade and high school. A chemical laboratory will be installed in same. Estimated cost, \$100,000. Howard Parsons, 600 Builders Exch., Minneapolis, Minn., archt.

### Tennessee

MEMPHIS—The Blount Plow Works, 149 South Front St., plans to construct a 2-story, 30x90-ft. building at 149 Front St. O. E. Hamilton, local mgr.

MEMPHIS—The Plough Chemical Co., 132 South 2nd St., is in the market for additional manufacturing equipment. Estimated cost, \$50,000.

### Virginia

NORFOLK—The Western Electric Co., 202 McKevitt Bldg., plans to build a transoceanic cable plant on a 50-acre site opposite the Navy Yard. F. W. Willard, Western Electric Company's Hawthorne station, Chicago, mgr.

### Wisconsin

KAUKAUNA—The Thilmany Pulp & Paper Co. will build a 3-story, 100x300-ft. addition to its plant. C. C. Hockley, chief engr. Work will be done by day labor.

MILWAUKEE—The Middle States Fdry. & Mfg. Co., 512 Ry. Exch. Bldg., has awarded the contract for the construction of a 1-story, 80x100-ft. foundry on Fraternity Pl., to J. M. Clark, 4111 Van Buren St. Estimated cost, \$20,000.

**RACINE**—S. C. Johnson & Son, 1012 16th St., will soon award the contract for the construction of a 4-story, 60x160-ft. warehouse and varnish plant on 16th St. A Guilbert, Robinson Block, archit. Kalbperly Corp., 31 Union Sq., W., New York City, engr.

**WEST ALLIS**—The Interstate Steel & Mfg. Co., 705 South Pierce St., Milwaukee, will build a 1-story, 80x200-ft. fabricating shop at 47th and Rogers Sts. Work will be done by day labor.

### Manitoba

**WINNIPEG**—The Canadian Government plans to install equipment to sterilize the water supply by ultra violet rays at all the public institutions here. G. Griexson, minister of Pub. Wks.

### Ontario

**FORT WILLIAM**—The Canada Iron Foundries Ltd., has awarded the contract for the construction of a 1-story, 46x80-ft. foundry, to M. H. Bradan, Francis Block. Estimated cost, \$20,000.

**WINDSOR**—The Essex Co. Tuberculosis Sanitarium, c/o Mrs. H. R. Casgrain, pres., plans to build a 2-story sanitarium. Medical equipment for tubercular treatment will be installed in same. Estimated cost, \$100,000.

## Coming Meetings and Events

THE AMERICAN CHEMICAL SOCIETY will hold its fall meeting in Chicago, Sept. 7 to 10 inclusive.

THE AMERICAN CHEMICAL SOCIETY, N. Y. Section, will hold a regular meeting June 11, at the Chemists' Club.

THE AMERICAN DROP FORGE ASSOCIATION will hold its seventh annual convention at the Marlborough-Blenheim Hotel, Atlantic City, N. J., June 17, 18 and 19.

THE AMERICAN ELECTROPLATERS' SOCIETY will hold its eighth annual convention in Rochester, June 30 to July 3. Headquarters will be at the Seneca Hotel.

THE AMERICAN FOUNDRYMEN'S ASSOCIATION will meet in Columbus, Ohio, Oct. 4 to 8 inclusive.

THE AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its twelfth semi-annual meeting as follows: June 28 and 29 will be spent in Montreal, June 30 in Ottawa, July 1 in Ontario, July 2 in Shawinigan Falls, July 3 in La Tuque, July 4 in Chicoutimi and July 5 in Quebec.

THE AMERICAN PHYSICAL SOCIETY will hold a meeting Nov. 27 at the Case School of Applied Science, Cleveland, and the annual meeting, beginning Dec. 28, at Chicago, the latter being the occasion of the special quadrennial meeting of the American Association for the Advancement of Science and the Affiliated Societies.

THE AMERICAN SOCIETY FOR TESTING MATERIALS will hold its annual meeting at the New Monterey Hotel, Asbury Park, N. J., June 22 to 25.

THE AMERICAN STEEL TREATERS' SOCIETY, Chicago, will hold its second annual convention and exhibit, combined with the convention of the Steel Treating Research Society of Detroit, Mich., in the Colliseum Museum, Philadelphia, Pa., Sept. 14 to 18 inclusive.

THE INSTITUTE OF METALS DIVISION OF THE A.I.M.E. will hold its usual joint meeting with the American Foundrymen's Association at Columbus, Ohio, during the week beginning Oct. 4.

THE INSECTICIDE AND DISINFECTANT MANUFACTURERS' ASSOCIATION will hold its mid-summer meeting at Boston, July 15 and 16.

THE IRON AND STEEL INSTITUTE (British) will hold its autumn meeting at Cardiff by invitation of the Ironmasters and Steel Manufacturers of South Wales and Monmouthshire. The date of the meeting will be Tuesday, Sept. 21, for the assembling of the members at Cardiff, and the formal proceedings will open on the morning of Wednesday, Sept. 22.

THE SIXTH NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES will be held in the Grand Central Palace, New York City, Sept. 20 to 25.

THE NATIONAL FERTILIZER ASSOCIATION will hold its twenty-seventh annual convention at the Greenbrier, White Sulphur Springs, W. Va., the week of June 21.

THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION will hold its twenty-seventh annual meeting June 29 to July 3, at the University of Michigan, Ann Arbor, Mich.

## Manufacturers' Catalogs

THE NATIONAL COMPRESSED AIR MACHINERY Co., Los Angeles, Cal., calls attention to Bulletin No. 20, devoted to National class "D" vertical air compressors. Described, together with some illustrations, are compressors as follows: Duplex, vertical balanced construction, permitting of high speeds, high capacity per unit of weight and floor space, and freedom from vibration; three main bearings, carried on the main frame, and fitted with laminated shim brass of 0.002-in. thickness; single acting type, eliminating stuffing boxes, but embodying the National combined piston-cross-head feature, with its attendant pump automatically controlled cylinder lubrication—not an oiler or grease cup on the machine. The valves are a happy medium between the old, heavy, self-destructive poppet type and many of the later delicate, so-called plate types. Inlet and outlet valves are interchangeable. One extra is furnished with each machine, and any broken valve replaced free for two years from shipment of compressor. The dimensions of the extra heavy shaft are published in the bulletin that all may see. Shaft is keyseated on both ends, making it a truly right and left hand machine as shipped. May run in either direction at will. Water jackets completely surround the cylinders and heads, including the discharge valve caps.

## New Publications

**REFRACTORY MATERIALS AS A FIELD FOR RESEARCH.** By Edward W. Washburn. Reprinted from the *Journal of the American Ceramic Society* of January, 1919, vol. 2, No. 1, by the National Research Council, reprint No. 3, price 30c.

**NITROGEN: ITS FIXATION, ITS USES IN PEACE AND WAR.** By Grinnell Jones. Reprinted from the *Quarterly Journal of Economics*, vol. 34, May, 1920, Harvard University, Cambridge, Mass.

**LIST OF REFERENCES ON DYESTUFFS, CHEMISTRY, MANUFACTURE, TRADE.** Compiled under the direction of Herman H. B. Meyer. From the Library of Congress, Government Printing Office. Price 15c.

**The Inco** is the title of the publication of the International Nickel Co., vol. 1, No. 1 of which appeared in February, 1920.

**TNT AS A BLASTING EXPLOSIVE.** By Charles E. Munroe and Spencer P. Howell. Dept. Circular 94, U. S. Department of Agriculture, Washington, D. C., issued, May, 1920.

**THE ELECTRIC FURNACE AS APPLIED TO METALLURGY.** Reprinted from the *Transactions of the American Electrochemical Society*, vol. 37, 1920, by Arthur D. Little, Inc., Cambridge, Mass., and known as Bibliographic Series No. 4.

**A CHEMICAL SURVEY OF THE NATURAL GASES OF KANSAS AND OKLAHOMA.** By H. C. Allen and E. E. Lyder. Engineering Bull. No. 11, published by the University of Kansas, Lawrence, Kan.

**ELECTROMETALLURGICAL AND ELECTRO-CHEMICAL INDUSTRY IN THE STATE OF WASHINGTON.** By Charles D. Grier. Engineering Experiment Station Series Bull. No. 5, University of Washington, Seattle, Wash.

**AN INVESTIGATION OF THE PROTECTIVE VALUES OF STRUCTURAL STEEL PAINTS.** By J. S. Coye. Bull. 54, Good Roads Section, Engineering Experiment Station, Iowa State College of Agriculture and Mechanic Arts, Ames, Iowa.

**THE RELATION BETWEEN THE ELASTIC STRENGTHS OF STEEL IN TENSION, COMPRESSION, AND SHEAR.** By Fred B. Seely and William J. Putnam. Bull. No. 115, Engineering Experiment Station, University of Illinois, Urbana, Ill. Price 20c.

**THE FOREST PRODUCTS LABORATORY, Madison, Wis., has published the following:** "The Use of Fluorides in Wood Preservation": 14 pages, with tables and bibliography; discusses in detail the results of experiments in Europe and America, and shows that sodium fluoride has considerable preservative value. "Automatic Regulation of Humidity in Factories," 4 pages, illustrated; reprint from *Scientific American Monthly*, January, 1920; describes apparatus developed at the Forest Products Laboratory for automatic control of moisture content in wood products during manufac-

ture. "Wood Ashes and Production of Potash," 5 pages, illustrated; reprint from *CHEM. & MET.*, Nov. 12-19, 1919.

THE BUREAU OF FOREIGN AND DOMESTIC COMMERCE has published the *Commercial Handbook of China*, by Julean Arnold, in two volumes, with a total of 1,100 pages.

**STATE AMERICANIZATION.** By Fred Clayton Butler. Bull. 1919, No. 77, published by the Bureau of Education, Department of the Interior, Washington, D. C.

**COMMUNITY AMERICANIZATION, a handbook for workers.** By Fred Clayton Butler. Bull. 1919, No. 76, published by the Bureau of Education, Department of the Interior, Washington, D. C.

**U. S. TARIFF COMMISSION PUBLICATION:** Tariff Information Series No. 14, The Incandescent Gas-Mantle Industry.

**NEW FEDERAL BOARD OF VOCATIONAL EDUCATION PUBLICATIONS:** Bull. 45, Job Specifications; Bull. 46, The Turnover of Labor; Bull. 47, Industrial Accidents and Their Prevention.

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